# Ornamental Plants

## Annual Reports and Research Summaries

THE OHIO STATE UNIVERSITY
OARDC

Special Circular 152
January 1996
Ohio Agricultural Research and Development Center
Wooster, Ohio

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The Ohio State University
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1-96-5M

# Ornamental Plants

## Annual Reports and Research Summaries

Edited By
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The Ohio State University
Horticulture and Crop Science


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Front Cover: Dave Shetlar, Ohio State University Extension entomologist, checks crabapples for insects.

# The Ohio State University Extension Nursery, Landscape, and Turf Team (ENLTT)

## Who

The Ohio State University Extension Nursery, Landscape, and Turf Team (ENLTT) is a group of 24 Ohio State University professionals (see Directory on page 3 of this Circular) from a number of Ohio State University departments and field Extension offices.

## What

"The mission of the Extension Nursery, Landscape, and Turf Team, through our interdisciplinary and industry partnerships, is to improve the process of development, acquisition, delivery, and support of accurate, practical, and timely educational resources."

This shared mission is an important key to the development in the past several years of a new team approach for OSU Extension for the nursery, landscape, and turf industries in Ohio. First, some history is in order.

## When

In 1992, seven key faculty members in the horticulture department of The Ohio State University retired, including Dr. Elton Smith, then the Nursery/Landscape Extension specialist in the department. With these retirements, and with continuing and projected budgetary constraints for public funds for horticultural and agricultural Extension in Ohio and the United States, the question was asked: What does Ohio State University Extension have to offer Ohio's nursery and landscape industries?

One answer was that, even with those key retirements, there were still numerous people and resources available within the University—in the departments of agronomy, entomology, horticulture, and plant pathology [agronomy and horticulture have since merged into the horticulture and crop science department]. There were numerous field faculty of Ohio State University Extension throughout the state. There were people at the Agricultural Technical Institute. They were not organized, however, as a coordinated recognizable team for the industry to work best with them. Nor were they organized in terms of their own planning. From a realization of this, ENLTT was born.

## How

Remember that the idea of ENLTT grew from discussions about a budgetary crisis in the University, in the level of generalized public support for Extension. Because of this, a fundamental aspect for the Team was working with the green industry for a measure of "user fees" from those most directly benefiting from what we do.

With this in mind, ENLTT made a proposal for funding support from the Ohio Nursery and Landscape Association (ONLA), the major nursery/landscape green industry organization in Ohio. The following statement from the 1993, 1994, 1995, and 1996 proposals to ONLA best illustrates the rationale behind this relationship:

"The overarching theme of this proposal and of the anticipated renaissance of the horticultural delivery system in Ohio is the concept of partnership: A partnership of field and departmental members, a partnership of all departments delivering horticultural information, and a partnership between the University, the industry, and the citizens of Ohio. Working together we can be quite a Team."

From 1993–1996 the Ohio Nursery and Landscape Association has generously supported ENLTT with funds for specific ENLTT proposals, and the Ohio chapter of the International Society of Arboriculture has funded a proposal by ENLTT in 1995. These funds are used for many purposes, including development of slide sets, development of inservices and programs for Extension and the green industry, support for enhancing the Ohio State University Short Course, provision of up-to-date resources to horticulture Extension agents so they can better aid the industry, travel costs of Extension agents beyond traditional county areas, and much more.

Probably the most important use of support, however, is for communications and computer costs for production of the *Buckeye Yard and Garden Line (BYGL).* The *BYGL* is sent out to Extension offices in Ohio and numerous other states to provide timely (weekly) plant problem updates from April–October. It is also available to the green industry from Ohio State University FAX centers by FAX subscription. And it is accessed by many thousands more on the World Wide Web and Internet through servers such as the Ohio State University Horticulture in Virtual Perspective and PenPages. Key *BYGL* items for each year are also summarized in this Ornamentals Circular.

The impact of *BYGL* is evident in these selected items from the 1995 *BYGL* Evaluation Survey:

- 99% of 251 survey respondents strongly agreed or agreed that "BYGL was useful to my job or business."
- 93% of respondents strongly agreed or agreed that "BYGL was useful in identifying plant problems."
- 99%+ of respondents strongly agreed or agreed that they "want BYGL to continue in 1996."
- 2,372 persons read the BYGL weekly from the subscriptions of the 251 survey respondents.

## Where

ENLTT members are spread throughout the state of Ohio. See Directory on page 3 of this Circular.

## Why

The relationship of ENLTT with the Ohio Nursery and Landscape Association and the overall green industry is a productive model of University/industry partnership in an age of ever-reduced general funding for universities. It provides a cost-effective way to help promote the building of a team of people who are better equipped to assist the industry through support by and for the representatives of the industry.

# Extension Nursery, Landscape, and Turf Team (ENLTT) Directory

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**Please Note**

On March 9, 1996, some, but not all, of the telephone numbers having a 216 Area Code will be changed to Area Code 330. Wooster numbers will become Area Code 330.

Please check with your telephone company for information about changes involving other 216 Area Code numbers.

# An Evaluation of Composts for Landscape Soil Amendments

Mary Ann Rose and Hao Wang

## Abstract

This study evaluated the suitability of four types of composted waste materials as soil amendments for bedding plants and examined the effect of these amendments with or without sulfur (3 lbs. per 100 sq. ft) on the soil pH. Two sources of composted municipal sludge (CMS), composted yardwaste, composted leaves, and peat were applied in two-inch layers and incorporated into field soil. The four annual species chosen varied in response to the soil amendments; overall, the amendments improved growth or appearance in at least some annual species compared to unamended field soil. The ranking of treatments, in terms of their benefit to plant growth, was peat > CMS (both sources) > composted yardwaste > composted leaves > unamended soil. Amending soil with composted leaves, composted yardwaste, and CMS significantly increased soil pH in some of the samples; however, soluble salt levels in soil were not affected. Sulfur addition effectively lowered soil pH 0.6 units two months after application and increased soluble salts.

## Introduction

There are potential benefits from using composted organic waste materials as soil amendments in the landscape. These materials are produced throughout the country as a solution to waste disposal problems and are economically attractive compared to traditional soil amendments such as peat.

Mary Ann Rose,Ohio Agricultural Research and Development Center/Ohio State University Extension/Horticulture and Crop Science; Hao Wang, Horticulture and Crop Science

Several types of compost are available, depending on the locality. Most recently, composted yardwaste has been produced in response to curbside yardwaste bans (Glenn, 1991). Relatively little is known about the suitability of this product as a landscape soil amendment. Other products, such as composted leaves, have been available for years. Composted municipal sludge (CMS) has been investigated extensively for over a decade, and many studies have demonstrated growth enhancement of ornamental species with its use (Smith and Treaster, 1985, 1991b; Ticknor et al., 1985; Devitt et al., 1991; Purman and Gouin, 1992).

In a two-year study at The Ohio State University, Smith and Treaster (1991a, 1992) found that CMS improved growth in nine of 12 annual bedding plant species. Growth of aster, geranium, and dusty miller was decreased or inconsistent in CMS treatments. Some problems associated with CMS use as a soil amendment include high soluble salts and high pH; soluble salts may have contributed to poor growth in the Ohio State study.

The objectives in this study were to evaluate four composted waste materials that are available in Ohio and to compare their effects on the soil and bedding plant growth compared to peat and unamended field soil. The four compost products used were:

- Composted yardwaste, marketed as Earthblend.
- CMS from the city of Akron, marketed as TechnaGro.
- CMS from the city of Columbus, marketed as Comtil.
- Composted leaves.

A second objective of the study was to examine the effect of the high-pH composts, with and without sulfur addition, on soil pH over the course of the growing season.

## Materials and Methods

Research plots were located at the Ohio State University, on a Crosby silty-clay-loam soil. Soil tests indicated a relatively high level of fertility in the soil (soil analysis in lbs/A: 156 phosphorus, 663 potassium, 5310 calcium, and 826 magnesium). Five soil amendments were used — composted yardwaste, composted municipal sewage sludge from two Ohio cities (CMS–Akron and CMS–Columbus), composted leaves, and peat.

In June 1995, a two-inch layer of each amendment was applied to field soil plots and rototilled six inches deep. A sixth treatment (control) consisted of rototilled field soil with no amendment. Sulfur was incorporated at two rates, 0 and 3 pounds per 100 square feet. Each four- by 10-foot plot was planted on July 3, 1995, with four bedding plant species — 'Orbit' geranium, 'State Fair' zinnia, 'Scarlet Sophia' marigold, and 'Dream Red' petunia. Each treatment was replicated three times. All plots were fertilized on July 10 with 18-6-12 slow release fertilizer at 60 lbs. N per acre.

Soil from each plot was sampled July 7, August 10, and October 2. Soil samples were tested for soluble salts (electrical conductivity, EC) and pH. On September 15, visual ratings of all plots were taken before plants were harvested for fresh and dry weights.

## Results and Discussion

**Soil Amendment Effect on Growth** The spring and early summer of 1995 were extremely wet, and soil amendments in most cases appeared to improve growth and ameliorate water-logging in the heavy field soil. With the exception of composted leaves, all soil amendments significantly improved the growth and increased fresh or dry weights in some of the annual species compared to unamended soil (Tables 1, 2, 3). Petunias were most responsive to soil amendments and exhibited the widest range in growth responses. Petunias in the control plots were poor in appearance, while control plots of the other three species were acceptable in appearance. Zinnia was the least responsive of the species to the soil amendments. Only peat improved visual ratings in zinnia, while no treatment improved their fresh or dry weights relative to the control.

All four species of bedding plants amended with peat were rated significantly higher than the controls. In general, the peat plots produced the greatest number of superior plants and greater fresh and dry weights. The two CMS amendments increased the visual ratings and dry weights in two of the four species (geranium and petunia). Composted yardwaste increased visual ratings and fresh and dry weights of petunia only.

Although composted leaves did not *statistically* increase weight or visual ratings in any bedding plant species, these trends were apparent in the data (Tables 1, 2, 3).

**Soil Amendment Effect on Soil EC and pH** Soil amendments did not significantly increase soil soluble salts in any of the three sample dates (Table 4). However, soil pH was significantly increased by most of the composted waste materials. Soil pH was increased by as much as 1.1 unit. In general, the pH of the treatment plots was ranked in the following order — composted leaves > yardwaste > CMS–Columbus > CMS–Akron > control >> peat. Soil pH was decreased by at least a full unit in the peat-amended plots compared to unamended field soil. The effects of the amendments on soil pH were stable throughout all sample dates.

**Sulfur Effect on Soil Soluble Salts and pH** Sulfur significantly increased soluble salts and decreased soil pH in all sample dates (Table 5). Elemental sulfur is oxidized to sulfuric acid by microorganisms in the soil. Sulfuric acid releases sulfate ions in the soil, which contribute to soluble salts. While the effect of sulfur on soil EC was highly significant, no detrimental effect on growth was observed. The highest soluble

salt level attained was 1.0 mmhos cm, which should not injure plants.

Sulfur significantly reduced the pH in all sampling dates. In July, the average pH of the sulfur treatments was 0.2 units lower than the minus-sulfur treatments. The pH of the sulfur treatments continued to decrease with time, and by August, the average pH was 0.6 units lower than minus-sulfur treatments. The gradual reduction in soil pH with sulfur addition was expected, because the chemical reaction that takes place is temperature- and time-dependent.

Sulfur addition had no significant effect on the visual ratings and weights of bedding plants (data not shown); however, these species are not known for soil pH preferences.

**Conclusions** Bedding plant species varied in their response to the soil amendments, but in general, there was a clear trend that all soil amendments improved growth in at least some annual species. The ranking of treatments, in terms of their benefit to plant growth, was peat > CMS (both sources) > composted yardwaste > composted leaves > unamended soil. Since the CMS products have considerably more nutritive value than peat or the other materials, the results suggest that in this experiment, the improvement of soil physical characteristics was more critical than improvement of soil fertility. This is not surprising, given the very wet year in Columbus and the naturally high level of fertility present in the research field soil.

While the soluble salt and pH effect of the composts were not critical factors in this experiment, the evidence that composts may significantly increase soil pH and EC may be important with plants such as azaleas and rhododendrons. This group of plants prefers a lower pH and is sensitive to soluble salts. Attempting to lower soil pH with elemental sulfur could be detrimental if soluble salts were greatly increased as a result. Fortunately, soluble salts are subject to leaching by rainfall; thus, the soluble salts that accompany the sulfur reaction should not persist. A second year of work is planned to study the long-term effects of sulfur and composted waste materials on soil pH and EC.

**Table 1. The effect of composted soil amendments on visual ratings of bedding plants. Averages of visual observations made September 15, 1995.**

| Amendment | Geranium | Marigold | Petunia | Zinnia |
|---|---|---|---|---|
| Peat | 3.9a | 3.9a | 3.7a | 4.0a |
| CMS–Akron1 | 3.9a | 3.5ab | 3.0bc | 3.2ab |
| CMS–Columbus | 3.2ab | 4.2a | 3.5ab | 3.4ab |
| Composted Yardwaste | 3.1ab | 3.8ab | 3.3abc | 3.6ab |
| Composted Leaves | 3.5ab | 3.5ab | 2.8cd | 3.4ab |
| Control (No Amendment) | 2.7b | 2.9b | 2.2d | 2.7b |
| Minimum significant difference | 1.1 | 1.0 | 0.6 | 1.2 |

Growth and quality were rated on a 1 to 5 scale. 5 = excellent, 4 = good, 3 = acceptable, 2 = poor, 1 = very poor. Treatments followed by the same letter are not significantly different.

**Table 2. The effect of composted soil amendments on fresh weights (grams) of bedding plants, September 15, 1995.**

| Amendment | Geranium | Marigold | Petunia | Zinnia |
|---|---|---|---|---|
| Peat | 166ab | 866 | 185a | 379 |
| CMS–Akron | 218a | 767 | 128b | 360 |
| CMS–Columbus | 177ab | 865 | 136b | 350 |
| Composted Yardwaste | 199ab | 808 | 135b | 384 |
| Composted Leaves | 158ab | 831 | 98bc | 342 |
| Control (No Amendment) | 134b | 636 | 82c | 279 |
| Minimum significant difference | 81 | ns | 39 | ns |

Treatments followed by the same letter are not significantly different.
ns = no statistical differences among treatments.

**Table 3. The effect of composted soil amendments on average dry weights (grams) of bedding plants, September 15, 1995.**

| Amendment | Geranium | Marigold | Petunia | Zinnia |
|---|---|---|---|---|
| Peat | 25 | 132ab | 26a | 77 |
| CMS-Akron | 30 | 109ab | 18bc | 72 |
| CMS-Columbus | 27 | 127ab | 22ab | 64 |
| Composted Yardwaste | 30 | 133a | 20b | 70 |
| Composted Leaves | 27 | 120ab | 14c | 65 |
| Control (No Amendment) | 25 | 95b | 14c | 53 |
| Minimum significant difference | ns | 37 | 5 | ns |

Treatments followed by the same letter are not significantly different.
ns = no statistical differences among treatments.

**Table 4. The effect of compost addition on soil soluble salts (EC, mmhos·cm) and pH.**

| | July | | Aug. | | Oct. | |
|---|---|---|---|---|---|---|
| | EC | pH | EC | pH | EC | pH |
| Composted leaves | 0.44 | 7.7a | 0.47 | 7.5a | 0.75 | 7.4a |
| Composted yardwaste | 0.48 | 7.3b | 0.47 | 7.1ab | 0.78 | 7.2a |
| CMS-Columbus | 0.45 | 7.0bc | 0.38 | 7.0b | 0.71 | 7.0ab |
| CMS -Akron | 0.52 | 6.8cd | 0.42 | 6.8bc | 0.80 | 6.9ab |
| Control (no amendment) | 0.50 | 6.7d | 0.49 | 6.4c | 0.70 | 6.7b |
| Peat | 0.54 | 5.2e | 0.43 | 5.3d | 0.68 | 5.6c |
| Minimum significant difference | ns | 0.3 | ns | 0.5 | ns | 0.5 |

Treatments followed by the same letter are not significantly different.
ns = no differences among treatments.

Table 5. The effect of sulfur addition on soil soluble salts (EC, mmhos·cm) and pH.

| | July | | Aug. | | Oct. | |
|---|---|---|---|---|---|---|
| | EC | pH | EC | pH | EC | pH |
| minus S | 0.37 | 6.9 | 0.23 | 7.0 | 0.44 | 7.1 |
| plus S | 0.61 | 6.7 | 0.65 | 6.4 | 1.00 | 6.5 |

Compost treatments are averaged.
All differences are statistically significant.

## Literature Cited


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# Aesthetic Evaluation of Crabapples at Secrest Arboretum in Wooster, Ohio: 1994–1995

James A. Chatfield, Erik A. Draper, Kenneth C. Cochran, Peter W. Bristol, and Charles E. Tubesing

## Abstract

Ornamental crabapples (*Malus spp.*) in a replicated plot at the Secrest Arboretum of The Ohio State University's Ohio Agricultural Research and Development Center in Wooster, Ohio, were evaluated for ornamental effectiveness 14 times from October 1994 through September 1995. Crabapples with best overall aesthetic ratings (fruit, flower, foliage, form, disease and pest resistance) for those rating periods were, in order: 'Molten Lava,' 'Red Jade,' 'Sentinel,' 'Prairifire,' 'Donald Wyman,' 'Mary Potter,' 'Strawberry Parfait,' 'White Cascade,' *M. sargentii, M. baccata* 'Jackii,' 'Ormiston Roy,' 'Bob White,' *M. halliana* 'Parkmanii,' 'Red Splendor,' 'Sugar Tyme,' *M. floribunda* 'Indian Magic,' and *M. zumi* 'Calocarpa.' Of the 45 crabapples in the plot, 37 were rated as "highly ornamental" or better at some point during the year.

## Introduction

Crabapples are woody landscape trees that provide a number of ornamental features throughout the year. Unfortunately, landscapers and their customers often focus their attention on only one feature of a particular crabapple. One example is the focus on the term "flowering crabapple." Crabapples bloom for only a short period each spring (1,2). Conversely, many crabapples exhibit good foliar and fruit displays for many months.

A second example of concentrating solely on one feature is rating crabapples only for disease (3,4,). Disease ratings are quite useful, but are often used by educators, landscapers, and the public as the sole criterion for selection of crabapples. Again, disease susceptibility is only one aspect of the true landscape value of a particular crabapple.

The emphasis of this continuing study is to provide an accurate, year-round profile of selected aesthetic qualities for many of the crabapples available to landscapers and homeowners. Aesthetic qualities can include showiness of buds, flowers, bark, foliage, and fruits; flower and fruit longevity; tree size and form; disease expression or any subtleties that directly influence the ornamental effect of crabapples in the landscape.

## Materials and Methods

Forty-seven crabapples at Secrest Arboretum were rated 14 times between October 1994 and September 1995 (three separate ratings were made during bloom and combined for one average value). Crabapples were rated on 10-7-94, 11-4-94, 12-13-94, 1-3-95, 2-2-95, 3-2-95, 4-7-95, 4-29-95, 5-6-95, 5-13-95, 6-8-95, 7-7-95, 8-7-95, and 9-7-95. The crabapples are in a completely randomized block design with three replications

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of each crabapple. The plot was planted in 1984. This is the second year of a multi-year study (5).

Aesthetic ratings include flower, foliage, form, and fruit characteristics, and effects of disease and pest problems. The rating system is as follows:

1 = Exceptionally ornamental crabapple. Based on outstanding flower, foliage, fruit, or form at time of rating.

2 = Highly ornamental crabapple. Good flower, foliage, fruit, or form at time of rating.

3 = Adequate as a landscape crabapple. Not highly ornamental at time of rating.

4 = Substandard as an ornamental crabapple at time of rating.

5 = Ornamentally unacceptable as a landscape crabapple at time of rating. Not recommended for use in the landscape.

Ratings for the crabapples in this study were averaged for the three replications on each evaluation date. These ratings were then added to give an overall average rating for the year for each crabapple species or cultivar. Data presented in Table 1 include ratings for October 1994 – September 1995 as well as cumulative ratings and cumulative descriptive paragraphs for August 1993 – September 1995.

Growing conditions during the period of October 1994 – September 1995 included a mild winter compared to the extreme lows (to -28° F at Secrest Arboretum) in January 1994 (5). Rainfall during mid-spring to early summer was heavy, resulting in numerous apple scab infection periods and heavier apple scab incidence in the spring of 1995 compared to 1993–1994 (3).

## Results and Discussion

The multiple evaluations in this study were made because a single evaluation for disease or a single evaluation for the aesthetic qualities of crabapple is too limiting. Profiles of a selection's landscape effectiveness over the entire year is preferable.

Crabapples feature spring flowering; foliage effects in the spring, summer, and fall; fruits in the summer, fall, and winter; and form and texture characteristics throughout the year. Profiles that reflect the entire year of ornamental ratings are presented in Table 1.

Even with the 12 evaluations (26 over two years) there are many limitations to our study. First, it is only two years of data. Factors such as winter damage or severe disease in a given year may overly influence the ratings for that limited time period.

Second, due to time and experimental design constraints, we limited the evaluations to the 45 crabapples replicated in the plot. Many need to be added, including a number that rate highly in other reports (4,6,7). To address this issue, a new crabapple plot is being planted at Secrest Arboretum to include numerous new selections. A number of selections with consistently substandard ratings in the current plot will be excluded from future evaluations. These include: 'Henningii,' 'Hopa,' 'Madonna,' 'Radiant,' 'Ralph Shay,' 'Red Barron,' 'Royalty,' 'Ruby Luster,' *M. tschonoskii*, and 'Velvet Pillar.'

Third, the data is for only one site: Wooster, Ohio. Clearly crabapples vary in their ornamental effectiveness and disease susceptibility depending upon local environmental conditions. A number of other studies provide data on effectiveness over a wider range of geographical area (4,6,7). Some effort was made in 1995 to include information from other Ohio sites relative to disease susceptibility (8).

Fourth, aesthetic ratings inevitably involve some subjectivity by the evaluators. Personal preferences relative to plant form, flower color, fruit size, the importance of clean foliage, and other factors enter into the ratings. To partly address this, we involved guest evaluators to a limited extent in 1995 (see Table 2) and plan to include additional perspectives in future years.

In general, these results show that ratings are reasonably consistent, suggesting that ratings by authors Chatfield and Draper are not a major limiting factor to the overall reliability of the study. There are several key divergences, however.

Ratings for 'Strawberry Parfait' differ considerably, probably due to the unusual, erratic shape of this crabapple. As indicated in our above description of 'Strawberry Parfait,' its "unusual shape is not for every landscape."

Ratings for 'Bob White' at the September evaluation diverged a full two points, due to differing views of fruit effect. All evaluators liked the clean foliage and overall plant shape. Lee and Warren thought the abundant still-green fruits were sensational. Chatfield and Draper appreciated the yellow blush starting on the fruits. Bristol and Tubesing felt the green fruits were not yet ornamentally effective.

Ratings for 'Mary Potter' diverged considerably at the September rating, probably reflecting differing perspectives on the extent of the value of its weeping-spreading form in the landscape. Plant form and texture are probably the most subjective criteria involved in the aesthetic rating scheme used in this study.

**Table 1. Average Aesthetic Ratings for October 1994–September 1995, and Cumulative Descriptions, Aesthetic Ratings, and Best and Worst Ratings from August 1993–September 1995.**

| Crabapple | 94–95 Average | 93–95 Average | Best | Worst |
|---|---|---|---|---|
| **'Adams'** | 3.1 | 2.9 | 1.3 | 4.6 |
| {Deep red fruits, pink flowers.} Positives include firm, abundant tear-drop shaped fruits, and an attractive winter feature of flaking bark near the crown, grading into striated bark on upper trunk and branches. Negatives include fruit mummies that persisted from summer 1993 through September 1995, detracting from winter appeal, springtime bloom effect and summer appearance. Chlorotic foliage noted during summers. Moderate scab noted. No fireblight noted. | | | | |
| *M. baccata* **'Jackii'** | 2.7 | 2.8 | 1.3 | 4.0 |
| {Maroon-red fruits, white flowers, large tree.} Positives include large, glossy green leaves — by far the best foliage of any crabapple in the plot. In fall, contrast of yellow and rust colored leaves with attractive burgundy fruits is outstanding. Negatives include relative sparseness of fruit clusters and mediocre overall winter appearance. No scab or fireblight noted. | | | | |
| **'Beverly'** | 3.7 | 3.7 | 1.3 | 5.0 |
| {Bright pinkish-red fruits, white flowers.} Positives include impressive fruit display from late summer through early fall, and pink buds opening to snowy white flowers in spring. Negatives include persistent rotted fruits from mid-fall through winter. Fruits are partially eaten by birds, leaving an unsightly mess on the tree. Sprawling growth habit is somewhat awkward. No scab noted, moderate fireblight noted in 1994. | | | | |
| **'Bob White'** | 2.8 | 2.6 | 1.0 | 4.6 |
| {Yellow fruits, white flowers.} Positives include persistent, small, firm, yellow-gold fruits maturing by mid-winter into orange-gold color. It is a real standout in the winter landscape. Exceptional floral display of delicate white blossoms opening from pinkish-red buds. Negatives include fruit and floral display that alternates yearly from profuse to sparse. Summer appearance is mediocre, although foliage is clean. No scab or fireblight noted. For overall effect, this is the best yellow-fruiting cultivar in the plot. | | | | |

Table 1 (continued). Average Aesthetic Ratings for October 1994–September 1995, and Cumulative Descriptions, Aesthetic Ratings, and Best and Worst Ratings from August 1993–September 1995.

| Crabapple | 94–95 Average | 93–95 Average | Best | Worst |
|---|---|---|---|---|
| 'Candied Apple' | 3.3 | 3.2 | 2.0 | 4.0 |

{Cherry red fruits, pink flowers, weeping aspect of upper branches.} Positives include the irregular weeping habit, red-tinged foliage and namesake fruits. Negatives include fruit scab, which in heavy scab years such as 1995, negated all fruit effect by masking color with brown to grayish scab lesions. No fireblight noted. Unusual weeping nature of upper branches is not for every landscape.

| 'Centurion' | 3.4 | 3.3 | 1.6 | 4.6 |
|---|---|---|---|---|

{Glossy red fruits, rose-red flowers, open branching structure.} Positives include attractive blossoms, fruit display in late summer and early fall, rust-orange fall foliage effect, and for some, the unusual open branching structure. Negatives include dull, sparse fruits by mid-fall and gangly nature of tree. Light to moderate scab noted, except in 1995 with extensive scab present. No fireblight noted. This crabapple is not outstanding at any time of year except briefly during bloom.

| 'David' | 3.1 | 3.3 | 1.0 | 4.0 |
|---|---|---|---|---|

{Scarlet fruits, white flowers.} Positives include abundant snowy-white flower display, and rounded tree form. Negatives include yearly floral and fruit displays alternating from profuse to sparse, and fruit mummies from late fall to mid-winter. Light scab noted in most ratings, no fireblight noted. Mediocre overall except for impressive flower display in alternate springs.

| 'Dolgo' | 4.2 | 4.1 | 2.0 | 5.0 |
|---|---|---|---|---|

{Bright red-purple plum-like fruits, snowy-white flowers.} Positives include edible, almost fluorescent red-purple fruits, striking for a brief period from mid-summer to mid-August. Negatives include major fruit mess problems due to drop, plop, and rot. Lacks ornamental effect for much of the year. No scab or fireblight noted. This is one of the large-fruited cultivars that give crabapples a generally unwarranted bad reputation as a messy landscape tree.

| 'Donald Wyman' | 2.2 | 2.2 | 1.0 | 4.0 |
|---|---|---|---|---|

{Bright red fruits, white flowers, large tree.} Positives include excellent floral display, persistent glossy fruits effective into April in 1995, attractive exfoliating bark and good overall rounded growth habit. Negatives include fruit mummies in spring and early summer 1995. Scab blight in 1993-1994, moderate on both fruit and leaves in 1995. No fireblight noted. One of the best red-fruited, white-flowered crabapples in the plot.

| *M. floribunda* | 2.9 | 2.9 | 1.3 | 4.0 |
|---|---|---|---|---|

{Fruit yellow with red blush, white flowers.} Positives include airy floral display with pink-red buds opening to white flowers, attractive blend of yellow and cider-brown fruit colors in fall, feathery effect of pedicels in winter, and good overall form. Negatives include yellow flecking of foliage in summer, and relatively ordinary appearance for much of the year. Slight scab noted in 1995. No fireblight noted.

| *M. halliana* 'Parkmanii' | 2.8 | 2.8 | 1.0 | 4.0 |
|---|---|---|---|---|

{Red fruits, double pinkish white flowers.} Positives include light, airy delicate aspect as bloom emerges, fall and early winter fruit display featuring a commingling of golden yellow and "cider" red-brown fruits. Negatives include a mundane appearance through winter months. Slight scab noted. No fireblight noted.

Table 1 (Continued). Average Aesthetic Ratings for October 1994–September 1995, and Cumulative Descriptions, Aesthetic Ratings, and Best and Worst Ratings from August 1993–September 1995.

| Crabapple | 94–95 Average | 93–95 Average | Best | Worst |
|---|---|---|---|---|
| 'Harvest Gold' | 3.5 | 3.2 | 1.6 | 4.6 |

{Yellow to gold fruits, white flowers.} Positives include attractive fruits and contrast of clusters of yellow fruits with red pedicels in late fall. Negatives include long period of bland green fruit into mid-fall, and serious disease problems. Extensive scab noted. Fireblight severe in 1995 with hundreds of spur strikes following blossom infection.

| 'Henningii' | 3.9 | 3.9 | 1.6 | 5.0 |
|---|---|---|---|---|

{Orange-red fruits, white flowers.} Positives include profuse flowering, effective fruit display in early fall, and attractive bark. Negatives include ungainly splayed upright growth habit and unattractive leaves due to scab. No fireblight noted. Growth habit is a significant detriment to landscape use.

| 'Hopa' | 4.4 | 4.2 | 2.0 | 5.0 |
|---|---|---|---|---|

{Red fruits, muted purple to pink flowers.} Positives include pastel flower show in spring. Negatives include ungainly overall tree form, and severe scab on leaves and fruits. No fireblight noted.

| 'Indian Magic' | 2.9 | 2.9 | 1.3 | 4.0 |
|---|---|---|---|---|

{Red-orange fruits, pink flowers.} Positives include outstanding fall fruit display of autumnal orange-red fruits with golden yellow undersides often contrasting with apricot-orange fall foliage color, appealing pink floral show in spring, and attractive bark. Negatives include yearly scab problems, with nearly complete defoliation from scab in 1995 by mid-to-late summer, although fruit scab is typically minimal. Fruit mummies were unsightly. No fireblight noted.

| 'Indian Summer' | 3.0 | 3.0 | 1.6 | 4.0 |
|---|---|---|---|---|

{Red fruits, rose-red flowers.} Positives include prolific mid-summer to fall display of red fruits, the contrast of fruits to orange fall foliage and flaky bark. Negatives include persistent fruit mummies and moderate to extensive scab on leaves. No fireblight noted.

| 'Jewelberry' | 3.3 | 3.4 | 2.3 | 5.0 |
|---|---|---|---|---|

{Red fruits, white flowers.} Positives include attractive, three-lobed leaves, good fruit display in fall, and overall diminutive plant form. Negatives include dingy overall appearance in summer months and extensive foliar scab. No fireblight noted. Significant winter injury occurred in 1994.

| 'Liset' | 3.3 | 3.3 | 2.0 | 4.6 |
|---|---|---|---|---|

{Maroon-red fruits, rose-red flowers.} Positives include very attractive fruit display from mid-summer to fall, contrast of fruits with peach colored fall foliage, and attractive summer foliage. Negatives include unattractive fruit mummies in late fall, and awkward splayed growth habit. Light to moderate (1995) scab noted. Fireblight not noted. Unusual, apparently normal splitting of bark on stems is characteristic.

| 'Mary Potter' | 2.3 | 2.5 | 1.0 | 3.3 |
|---|---|---|---|---|

{Red fruits, white flowers, weeping-spreading habit.} Positives include profuse pink buds opening to exquisite blossom display, elegant spreading growth habit, masses of reddish fruits, and salmon colored young bark revealed as older bark peels away. Negatives include fruit mummies in winter months and some branch dieback due to winter injury in 1994. Light scab and fireblight noted.

Table 1 (Continued). Average Aesthetic Ratings for October 1994–September 1995, and Cumulative Descriptions, Aesthetic Ratings, and Best and Worst Ratings from August 1993–September 1995.

| Crabapple | 94–95 Average | 93–95 Average | Best | Worst |
|---|---|---|---|---|
| 'Molten Lava' | 1.6 | 1.7 | 1.0 | 2.6 |

{Red-orange fruits, white flowers, spreading-weeping habit.} Positives include fiery red fruits, yellowing fall foliage and cascading branch structure, providing an overall "molten lava" effect. Excellent winter ratings due to overall plant structure including layered horizontal branching, feathery red pedicel effect in winter, and attractive blooms. Negatives include dense, somewhat cluttered foliage effect in summer and dinginess from scab in 1995. Slight scab in 1994, moderate to extensive in 1995. No fireblight noted.

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|---|---|---|---|---|
| 'Ormiston Roy' | 2.7 | 2.7 | 1.6 | 4.0 |

{Orange-yellow fruits, white flowers.} Positives include attractive orange fruits in the fall, deep-furrowed orangish bark, and good floral show. Negatives include mummified fruit, with mummies from 1993 persisting through winter 1995. Slight scab in 1995, slight fireblight in 1994.

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|---|---|---|---|---|
| 'Prairifire' | 2.2 | 2.4 | 1.3 | 4.0 |

{Purple-red fruits, coral-red flowers.} Positives include attractive show of firm purplish fruits, spectacular bloom with flowers contrasting with emerging red-tinged green foliage, fall contrast of orangish spur leaves with fruits and other foliage, and lenticel-speckled bark. Negatives include nondescript winter and early summer appearance. No disease noted; very clean foliage.

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|---|---|---|---|---|
| 'Professor Sprenger' | 3.6 | 3.5 | 1.8 | 4.6 |

{Orange-red fruits, white flowers.} Positives include attractive white flowers and orange-red fruits. Negatives include persistent mummified fruits, and overall unsightliness due to heavy frogeye leaf spot, which resulted in significant defoliation. Moderate scab in 1995, extensive yearly frogeye leaf spot. No fireblight noted.

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|---|---|---|---|---|
| 'Profusion' | 3.4 | 3.2 | 2.0 | 5.0 |

{Red fruits, purple-red flowers.} Positives include effective, abundant, cherry-red fruits in the summer. Negatives include lack of contrast between purple-bronze colored foliage and fruits and flowers, mediocre winter appearance including rotted fruits, and extensive unsightliness and defoliation from apple scab, especially in 1995. No fireblight noted.

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| 'Radiant' | 4.4 | 4.0 | 2.0 | 5.0 |

{Bright red fruits, deep pink flowers, foliage red-purple fading to bronze.} Positives include pink blossoms and almost neon-red fruits evident in late summer. Negatives include severe scab resulting in prohibitively extensive defoliation and fruit unsightliness.

| | | | | |
|---|---|---|---|---|
| 'Ralph Shay' | 3.8 | 3.5 | 2.0 | 5.0 |

{Large red fruits, white flowers.} Positives include pleasing floral show and bright red fruits before codling moth larval damage makes fruit unsightly. Negatives include ugliness of fruits throughout most of the year, including rotted mummies. Light scab in 1994, extensive scab in 1995. No fireblight noted.

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| 'Red Barron' | 3.8 | 3.5 | 1.6 | 5.0 |

{Dark red fruits, reddish-pink flowers.} Positives include interesting pumpkin-shaped fruits and exfoliating bark. Negatives include mummified fruits that persisted from 1993 through summer 1995, gangly overall tree form, and scab problems that were extensive in 1995. No fireblight noted.

Table 1 (Continued). Average Aesthetic Ratings for October 1994–September 1995, and Cumulative Descriptions, Aesthetic Ratings, and Best and Worst Ratings from August 1993–September 1995.

| Crabapple | 94–95 Average | 93–95 Average | Best | Worst |
|---|---|---|---|---|
| **'Red Jade'** | 1.9 | 2.2 | 1.6 | 4.0 |

{Red fruits, white flowers, spreading-weeping growth habit.} Positives include graceful spreading growth habit in fall and winter months, attractive fruits, and red flower buds opening into white blossoms. Negatives include some fruit rotting in early winter and moderate scab in 1995, causing some smudginess on fruits. No fireblight noted.

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| **'Red Jewel'** | 3.1 | 2.8 | 1.3 | 4.6 |

{Cherry red fruits, white flowers.} Positives include attractive, persistent fruits into the winter months, clean summer foliage, and attractive blooms. Negatives include unappealing late winter to early spring appearance and some fruit mummies. No scab noted. Fireblight moderate.

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|---|---|---|---|---|
| **'Red Splendor'** | 2.8 | 2.7 | 1.6 | 4.3 |

{Roundish red fruits, rose pink flowers, red tinged foliage.} Positives include exceptional profuse red fruits from early summer to mid-fall, lovely pink flowers, and attractive exfoliating bark. Negatives include poor winter ratings due to rotted, half-eaten fruits. Trace of scab in 1994 and moderate scab in 1995. No fireblight noted.

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|---|---|---|---|---|
| **'Robinson'** | 3.8 | 3.6 | 2.3 | 4.6 |

{Dark red fruits, deep pink flowers.} Positives include peach to burnt orange colored fall foliage, abundant fruits, and attractive flowers. Negatives include poor winter ratings due to rotted fruit and overall coarseness, and extensive to heavy scab in summer months, resulting in considerable defoliation in 1995. No fireblight noted.

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|---|---|---|---|---|
| **'Royalty'** | 4.7 | 4.3 | 2.6 | 5.0 |

{Red-purple fruits, crimson flowers, dark purple foliage.} Offers little ornamentally except where purple leaf color is desired. Negatives include poor ratings in winter due to overall plant form and horrific, blackened fruit mummies, and little contrast between foliage and flowers and developing fruit. Light scab in 1994; extensive scab in 1995. No fireblight noted.

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|---|---|---|---|---|
| **'Ruby Luster'** | 4.6 | 4.4 | 3.0 | 5.0 |

{Rose-purple fruits, pink flowers.} Large tree with ugly, misshapen fruits. Light scab in 1994; tree virtually defoliated by scab in 1995. No fireblight noted. Not an effective ornamental tree.

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|---|---|---|---|---|
| **M. sargentii** | 2.7 | 3.1 | 2.0 | 4.3 |

{Red fruits, white flowers, dwarf spreading habit.} Positives include attractive, low-spreading growth habit, fine snowy white blossom show, effective firm fruits in late summer to early fall, and clean foliage except for Japanese beetle feeding. Negatives include shrivelling of fruits by mid-fall persisting into winter. Winter injury in January of 1994. No scab or fireblight noted.

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|---|---|---|---|---|
| **'Selkirk'** | 3.8 | 3.7 | 1.6 | 5.0 |

{Glossy red fruits, rose-red flowers.} Positives include excellent floral show and combination of flowers with glossy red-tinged new foliage, and striking medium-large fruits in mid-summer. Negatives include deformation of fruits from codling moth larval feeding in late summer, unattractive late summer foliage and moderate fruit and foliar scab, and poor ratings in winter due to coarse, dreary overall appearance. No fireblight noted.

Table 1 (Continued). Average Aesthetic Ratings for October 1994–September 1995, and Cumulative Descriptions, Aesthetic Ratings, and Best and Worst Ratings from August 1993–September 1995.

| Crabapple | 94–95 Average | 93–95 Average | Best | Worst |
|---|---|---|---|---|
| 'Sentinel' | 2.0 | 2.2 | 1.0 | 4.0 |

{Red fruits, red-pink buds open to pink-tinged white flowers, vase-shaped growth habit.} Positives include mostly upright habit, sensational floral display, pleasing yellow fall foliage contrast with fruits, and attractive firm fruits persisting well into winter. Negatives include unattractive fruit mummies by spring and into the summer and nondescript summer appearance. Trace of scab noted. No fireblight noted.

| 'Silver Moon' | 3.1 | 3.4 | 1.6 | 5.0 |
|---|---|---|---|---|

{Purple-red fruits, white flowers.} Positives include dense upright form, snowy white floral show (limited bloom in 1995), attractive fruits, and very clean foliage. Negatives include poor winter ratings due to cluttered growth habit and significant fireblight problems. No scab noted.

| 'Snowdrift' | 3.1 | 3.1 | 1.3 | 4.0 |
|---|---|---|---|---|

{Salmon-red fruits, white flowers.} Positives include excellent flower display, attractive fruits, and feathery effect of pedicels in winter. Negatives include shrivelled fruits by late fall, poor overall foliar color, and extensive scab. No fireblight noted. Most ratings mediocre.

| 'Strawberry Parfait' | 2.3 | 2.4 | 1.6 | 3.6 |
|---|---|---|---|---|

{Fruits start yellow with increasing red blush, flowers pink.} Positives include early red-tinged foliage effect, profuse pink blossoms, unusual erratic upright-spreading growth habit, good fall color, and firm fruits in fall and through mid-winter. Negatives include some fruit mummies and unusual shape is not for every landscape. Clean foliage; no scab or fireblight noted.

| 'Sugar Tyme' | 2.9 | 2.6 | 1.0 | 3.6 |
|---|---|---|---|---|

{Brilliant red fruits, white flowers.} Positives include stunning sugar-white floral display, showy, persistent and profuse fruits, and good overall form. Negatives include general mediocrity if flowers/fruits are not abundant, as in 1994 due either to winter effects or other factors. Slight scab noted. No fireblight noted.

| 'Velvet Pillar' | 3.8 | 3.7 | 3.0 | 5.0 |
|---|---|---|---|---|

{Reddish fruits, pink flowers.} Positives include upright growth habit and feature of purple foliage. Negative include dingy overall foliar appearance, sparseness of fruits, persistent fruit mummies and severe scab problems, including near total defoliation in 1995 by early August. Is not an effective ornamental at any time of the year.

| 'White Angel' | 3.6 | 3.6 | 2.3 | 5.0 |
|---|---|---|---|---|

{Red fruits, white flowers.} Positives include attractive flowers, showy, medium-sized, abundant fruits effective into fall (effect obscured by sooty blotch disease in 1995), and interesting red coloration of previous season's growth noted in March. Negatives include awkward growth habit (until tree is considerably older), and unattractive fruit mummies. No scab noted or fireblight noted.

| 'White Cascade' | 2.6 | 2.5 | 1.0 | 4.3 |
|---|---|---|---|---|

{Small yellow fruits, white flowers, weeping growth habit.} Positives include exquisite flower display with waterfall of cascading white-covered branches, and appealing overall weeping form. Negatives include dingy appearance throughout summer due to scab, which was heavy by mid summer in 1995, with considerable defoliation. No fireblight noted. Fall and winter features are ordinary.

Table 1 (Continued). Average Aesthetic Ratings for October 1994–September 1995, and Cumulative Descriptions, Aesthetic Ratings, and Best and Worst Ratings from August 1993–September 1995.

| Crabapple | 94–95 Average | 93–95 Average | Best | Worst |
|---|---|---|---|---|
| 'Winter Gold' | 3.5 | 3.6 | 2.0 | 4.3 |

{Yellow fruits, white flowers.} Positives include impressive flower show in years where blooms are present (very sparse in 1995 on some replicates in plot), and attractive, butter-yellow fruits contrasted with bright red pedicels by mid fall. Negatives include extended periods of unattractive green fruits before yellowing in mid fall, and extensive fireblight strikes on replicate that flowered heavily in 1995. Scab extensive in 1995, moderate in 1994.

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|---|---|---|---|---|
| *M. zumi* 'Calocarpa' | 2.9 | 3.1 | 1.3 | 4.3 |

{Bright red fruits, white flowers.} Positives include excellent flower show, clusters of abundant, tiny red fruits in fall, and nuances such as fine feature of feathery pedicels in winter. Negatives include shrivelled fruits and overall poor winter ratings. Slight to moderate scab noted.

1 = Exceptionally ornamental crabapple. Based on outstanding flower, foliage, fruit, or form at time of rating.
2 = Highly ornamental crabapple. Good flower, foliage, fruit, or form at time of rating.
3 = Adequate as a landscape crabapple. Not highly ornamental at time of rating.
4 = Substandard as an ornamental crabapple at time of rating.
5 = Ornamentally unacceptable as a landscape crabapple at time of rating. Not recommended for use in the landscape.

Table 2. Comparisons of Author (A) Evaluations and Guest (B) Evaluations for Selected Crabapples and Selected Dates at Secrest Arboretum: 1995.

| Crabapple | 9-7-95 | | | 10-13-95 | |
|---|---|---|---|---|---|
| | A* | B1** | B2*** | A* | B3**** |
| 'Adams' | 3.0 | 3.0 | 3.3 | 3.3 | 3.1 |
| 'Bob White' | 2.0 | 3.0 | 1.0 | 2.0 | 1.8 |
| 'Indian Magic' | 3.0 | 2.0 | 3.0 | 1.0 | 1.6 |
| 'Mary Potter' | 1.0 | 2.0 | 2.0 | 1.0 | 1.6 |
| 'Radiant' | 4.6 | 4.6 | 4.0 | 5.0 | 4.3 |
| 'Red Barron' | 4.6 | 4.6 | 3.6 | 4.6 | 4.1 |
| 'Royalty' | 5.0 | 4.3 | 4.3 | 5.0 | 4.6 |
| 'Sentinel' | 3.0 | 2.6 | 2.3 | 2.3 | 2.7 |
| 'Snowdrift' | 3.3 | 3.0 | 3.6 | 2.0 | 1.8 |
| 'Strawberry Parfait' | 2.0 | 3.0 | 3.0 | 2.0 | 3.1 |

A* = J. A. Chatfield and E. A. Draper.
B1** = P. W. Bristol and C. E. Tubesing, Holden Arboretum.
B2*** = Mike Lee and Dick Warren, Manbeck Nurseries.
B3**** = Group of 14 Ohio Department of Natural Resources urban foresters.

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# Evaluation of Crabapples for Apple Scab at Secrest Arboretum in Wooster, Ohio: 1995

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## Abstract

Crabapples in a replicated plot at the Secrest Arboretum of The Ohio State University's Ohio Agricultural Research and Development Center were evaluated for apple scab four times in 1995. Ten of the crabapple selections exhibited no scab at any of the ratings; 20 of the selections exhibited scab rated as extensive and significantly damaging to plant aesthetics for at least one of the ratings. Apple scab was more severe in the plot in 1995 than in 1994, when 11 selections had ratings of significantly damaging scab. The same crabapple selections also were rated on one of the dates at Holden Arboretum and results were similar but with some major differences. Other diseases noted included bacterial fireblight, frogeye leaf spot, sooty blotch and flyspeck.

## Introduction

Apple scab (pathogen: *Venturia inaequalis*) is a major fungal disease problem of many crabapple species (*Malus spp*). Although it generally is not a major health problem for the tree, it can severely affect the ornamental value and marketability of highly susceptible crabapples.

Symptoms of apple scab on crabapple include olive to gray to brown to black spots on foliage, yellowing and discoloration of foliage, leaf drop, and scabby lesions on fruits. Apple scab can be effectively controlled with a fungicidal spray program. Certain cultural and sanitary practices, such as thinning to avoid dense canopies and cleanup of leaves at the end of the season, are also beneficial for control.

However, the best method for control of apple scab is through the use of genetically resistant crabapple selections. The evaluations presented here are the latest in a series of apple scab evaluations for Ohio (1,2,3,4,).

The authors emphasize that apple scab in particular and diseases and pests in general are not the only considerations relative to crabapple effectiveness in the landscape. This is the rationale for the inception of more comprehensive evaluations of a number of different aesthetic criteria. These include fruit, flower, and foliage features; plant texture and shape; and disease and pest problems. These are reported in a companion paper to this apple scab evaluation report (5,6).

## Materials and Methods

Forty-five crabapple selections in the Secrest Arboretum were rated for apple scab disease on June 8, 1995; July 7, 1995; August 7,1995; and September 7, 1995. Crabapples in the Secrest trial are arranged in a completely randomized design with three replications. Trees were planted in 1984 and are not treated with pesticides.

Apple scab evaluations were based on the following rating system:

0 = No scab noted.

1 = Slight scab; less than 5% of leaves affected; no negative effect on aesthetics.

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2 = Moderate scab; 5% to 20% of leaves affected; some yellowing; little or no defoliation; moderate negative effect on aesthetics.

3 = Extensive scab; 20% to 50% of leaves affected; significant defoliation and/or leaf yellowing; major negative effect on aesthetics.

4 = Heavy scab; 50% to 80% of leaves affected; severe defoliation and discoloration of leaves; severe negative effect on aesthetics.

5 = Extreme scab; 80% to 100% of foliage is affected and defoliation is complete or nearly complete.

Scab on crabapple fruits was factored into the overall scab ratings.

Other diseases noted in the plot included frogeye leafspot, fireblight, and sooty blotch and fly speck of fruits.

Frogeye leaf spot (pathogen: *Botryosphaeria obtusa*) is typically of minor concern relative to plant health and aesthetics, but on some selections causes significant leaf spotting, yellowing, and occasionally defoliation.

Fireblight (pathogen: *Erwinia amylovora*) is a serious bacterial disease causing blossom blight, twig and branch dieback, and leaf discoloration, and in extreme cases total plant death. Fireblight was not a problem on most crabapple selections in this plot.

Sooty blotch (pathogen: *Gloeodes pomigena*) and fly speck (pathogen: *Microthyriella rubi*) cause considerable smudginess of apple fruits and in 1995 caused considerable fruit unsightliness on several crabapple selections in the plot. Further comments on these diseases and on aesthetics of all 45 crabapples selections in the plot at Secrest Arboretum are presented in detail in the companion article in this Circular, "Aesthetic Evaluations of Crabapples at Secrest Arboretum in Wooster, Ohio: 1995."

## Results and Discussion

Spring and early summer weather of sustained rainy periods with moderate temperatures resulted in heavy scab pressure in 1995. In virtually all cases the scab ratings on the crabapple selections in the Secrest plot were greater in 1995 than for the previous two years and greater than the three-year (1993–1995) average scab ratings (see Table 1). A scab rating of 3 (extensive scab; 20% to 50% of leaves affected; significant defoliation and/or leaf yellowing; significant negative effect on aesthetics) occurred for at least one rating period on 20 selections in 1995, compared to 11 in 1994.

Of the 45 selections in this evaluation plot, there were 10 that exhibited no scab in 1995. Of these 10, *M. baccata* 'Jackii,' 'Bob White,' 'Prairifire,' 'Red Jewel,' *Malus sargentii*, and 'Strawberry Parfait' also had excellent aesthetic qualities and good resistance to other diseases. 'Beverly,' 'Dolgo,' 'Silver Moon,' and 'White Angel' were scab-free but had mediocre to poor overall aesthetic ratings. 'Silver Moon' also had significant fireblight problems.

Another 12 selections in the plot exhibited apple scab ratings under 2 for 1995, and 20 selections had average scab ratings under 2 for the 1993–1995 period. A rating of 2 in the author's rating scheme is the point at which moderate negative effects on overall plant aesthetics begin to play a role in ornamental effectiveness. Some of these selections with relatively low apple scab have other problems as effective landscape ornamentals. In addition, some of the selections with scab ratings of 2 or greater have redeeming ornamental features for some situations, at least for a portion of the year (5,6).

Scab ratings in this study were only for the 45 selections in the plot at Secrest Arboretum. This was done because the plot is replicated (6,7). However, there is additional data available for other locations and additional crabapple selections (1,2,3,4,7).

Of particular interest is the fall 1995 edition of *Malus* (7), which compiled data for the past 30 years from crabapple collections throughout the

United States. In many cases, data in 1995 at Secrest Arboretum was similar to the combined results reported in the *Malus* article, but there were a number of major differences.

These include:

- On the basis of Secrest data from 1993–1995, 'Adams.' 'Red Splendor,' Selkirk,' 'White Cascade,' Centurion,' 'Donald Wyman, 'Harvest Gold,' 'Henningii,' 'Jewelberry,' 'Profusion,' 'Molten Lava,' 'Ormiston Roy,' 'Professor Sprenger,' 'Red Jade,' 'Snowdrift,' 'Sugar Tyme,' and '(Weeping) Candied Apple' would not be identified as "highly resistant," as they are in the *Malus* article.

- On the basis of Secrest data, 'Royalty,' 'Indian Magic,' 'Indian Summer,' 'Ralph Shay,' 'Red Barron,' 'Ruby Luster,' 'Winter Gold,' and 'Velvet Pillar' would not be identified as "resistant," as they are in the *Malus* article.

There are numerous possible explanations for the differences in these reports. Following are two possibilities. First, scab may differ at other locations due to either less or more favorable environmental conditions for scab development. Second, there may be local races of *Venturia inaequalis* in certain locations.

In 1995, companion ratings of crabapples at both Secrest Arboretum and Holden Arboretum in Kirtland, Ohio, in northern Ohio near Lake Erie, were made in order to compare scab incidence for these two locations. Comparative data for these locations is presented in Table 2. Ratings for the two arboreta were generally similar, though scab was less severe at Holden Arboretum.

Crabapple selections with considerably lower scab at Holden included 'Red Splendor,' 'White Cascade,' 'Selkirk,' *M. zumi* 'Calocarpa,' 'Ormiston Roy,' and *M. floribunda*. Of greatest interest was the total absence of scab on 'Red Splendor' on 7-6-95 at Holden, while it exhibited moderate scab incidence at Secrest on 7-7-95.

Frogeye leafspot was present on most crabapples, but was aesthetically significant (leaf spotting, yellowing, and moderate defoliation) on only one selection in 1995, 'Professor Sprenger.'

Bacterial fireblight was present on six of the 45 selections — 'Harvest Gold,' 'Mary Potter,' 'Ormiston Roy,' 'Silver Moon,' 'Red Jewel,' and 'Winter Gold.' Fireblight was severe in 1995 only on 'Harvest Gold' and 'Winter Gold,' on which hundreds of blossom blight infections spread into relatively short (4" to 6" long) blighting of spur shoots, resulting in browning and blight of over 25 percent of the overall foliage of affected plants. 'Harvest Gold' and 'Winter Gold' in the plot that did not bloom this year (in the alternate year of their bloom cycle) did not exhibit fireblight, highlighting the importance of blossom infections in the fireblight disease epidemiology.

Two crabapple selections were removed from the plot this year due to complete death or near death from disease. These were *Malus tschonoskii* due to fireblight and 'Madonna' due to fireblight and frogeye leaf spot.

Two additional disease problems noted this year included sooty blotch and fly speck, which resulted in overall smudging and ineffectiveness of ornamental fruit display. Significant aesthetic problems with these diseases was noted in 1995 on the following crabapple selections: 'Professor Sprenger,' 'Red Jade,' and 'White Angel.'

Powdery mildew and rust diseases were completely absent in this plot for 1993–1995. Insect problems in the plot included apple thorn skeletonizer, Japanese beetle, spotted tentiform leafminer, and fall webworm, but ratings for individual crabapple selections were not made for 1993–1995, although this may be included in future trials.

Table 1. Apple Scab Ratings for Crabapple Selections at Secrest Arboretum in 1995 and for 1993–1995.

| Crabapple | 6-8-95 | 7-7-95 | 8-7-95 | 9-7-95 | 93-95 Average |
|---|---|---|---|---|---|
| 'Adams' | 2.6 | 2.3 | 2.0 | 2.0 | 1.6 |
| *M. baccata* 'Jackii' | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Beverly' | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Bob White' | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Candied Apple' | 3.0 | 2.6 | 3.0 | 4.0 | 1.6 |
| 'Centurion' | 2.0 | 2.0 | 3.0 | 3.0 | 1.4 |
| 'David' | 1.0 | 1.3 | 1.3 | 2.0 | 1.0 |
| 'Dolgo' | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Donald Wyman' | 1.0 | 1.7 | 2.0 | 2.0 | 1.1 |
| *M. floribunda* | 1.0 | 1.0 | 1.0 | 1.0 | 0.3 |
| *M. halliana* 'Parkmanii' | 1.0 | 1.0 | 1.0 | 1.0 | 0.5 |
| 'Harvest Gold' | 3.0 | 2.7 | 3.0 | 3.0 | 2.5 |
| 'Henningii' | 2.0 | 2.0 | 3.0 | 3.0 | 1.9 |
| *M. adstringens* 'Hopa' | 2.0 | 3.0 | 4.0 | 5.0 | 2.7 |
| 'Indian Magic' | 1.6 | 3.0 | 4.0 | 4.0 | 2.6 |
| 'Indian Summer' | 2.0 | 2.7 | 3.0 | 3.7 | 2.3 |
| 'Jewelberry' | 2.0 | 3.0 | 4.0 | 5.0 | 2.5 |
| 'Liset' | 0.0 | 1.0 | 2.0 | 2.0 | 0.9 |
| 'Mary Potter' | 1.0 | 1.0 | 1.0 | 1.0 | 0.6 |
| 'Molten Lava' | 1.0 | 1.7 | 2.0 | 3.0 | 1.2 |
| 'Ormiston Roy' | 1.0 | 1.0 | 1.0 | 1.0 | 0.4 |
| 'Prairifire' | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Professor Sprenger' | 1.0 | 1.7 | 2.0 | 2.0 | 0.8 |
| 'Profusion' | 2.0 | 2.3 | 3.0 | 4.0 | 2.8 |
| 'Radiant' | 2.0 | 3.0 | 3.7 | 4.0 | 3.0 |
| 'Ralph Shay' | 2.0 | 2.0 | 3.3 | 3.3 | 2.1 |
| 'Red Barron' | 2.0 | 3.0 | 3.0 | 4.0 | 1.6 |
| 'Red Jade' | 1.0 | 1.3 | 2.0 | 2.0 | 1.2 |
| 'Red Jewel' | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Red Splendor' | 1.6 | 2.0 | 2.0 | 2.3 | 1.4 |
| 'Robinson' | 2.0 | 4.0 | 4.0 | 4.2 | 2.6 |
| 'Royalty' | 2.0 | 2.0 | 3.0 | 4.0 | 1.6 |
| 'Ruby Luster' | 2.0 | 3.0 | 3.7 | 4.0 | 1.7 |
| *M. sargentii* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Selkirk' | 2.0 | 2.0 | 2.0 | 2.0 | 1.6 |
| 'Sentinel' | 1.0 | 1.0 | 1.0 | 1.0 | 0.7 |
| 'Silver Moon' | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'Snowdrift' | 2.0 | 2.7 | 3.0 | 3.0 | 2.2 |
| 'Strawberry Parfait' | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 'Sugar Tyme' | 1.0 | 1.0 | 1.0 | 2.0 | 0.7 |
| 'Velvet Pillar' | 2.0 | 2.7 | 5.0 | 5.0 | 2.8 |
| 'White Angel' | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 'White Cascade' | 2.0 | 3.0 | 3.7 | 4.0 | 2.1 |
| 'Winter Gold' | 1.0 | 2.7 | 3.0 | 3.3 | 2.2 |
| *M. zumi* 'Calocarpa' | 1.0 | 1.7 | 2.0 | 2.0 | 1.0 |

Apple scab ratings:

0 = No scab noted.

1 = Slight scab; less than 5% of leaves affected; no negative effect on aesthetics.

2 = Moderate scab; 5% to 20% of leaves affected; some yellowing; little or no defoliation; moderate negative effect on aesthetics.

3 = Extensive scab; 20% to 50% of leaves affected; significant defoliation and/or leaf yellowing; significant negative effect on aesthetics.

4 = Heavy scab; 50% to 80% of leaves affected; severe defoliation and discoloration of leaves; severe negative effect on aesthetics.

5 = Extreme scab; 80% to 100% of foliage is affected and defoliation is complete or nearly complete.

Scab on crabapple fruits was factored into the overall scab ratings.

Table 2. Comparison of Apple Scab Ratings at Secrest Arboretum (7-6-95) and Holden Arboretum (7-7-95).

| Crabapple | Secrest | Holden |
|---|---|---|
| 'Adams' | 2.3 | 2.0 |
| *M. baccata* 'Jackii' | 0.0 | 0.0 |
| 'Beverly' | 0.0 | 0.3 |
| 'Bob White' | 0.0 | 0.0 |
| 'Candied Apple' | 2.6 | 3.0 |
| 'Centurion' | 2.0 | 2.6 |
| 'David' | 1.3 | 0.6 |
| 'Dolgo' | 0.0 | 0.0 |
| 'Donald Wyman' | 1.6 | 2.6 |
| *M. floribunda* | 1.0 | 0.0 |
| 'Harvest Gold' | 2.6 | 2.3 |
| 'Henningii' | 2.0 | 2.6 |
| 'Hopa' | 3.0 | 3.6 |
| 'Indian Magic' | 3.0 | 2.0 |
| 'Indian Summer' | 2.6 | 2.0 |
| 'Jewelberry' | 3.0 | 2.0 |
| 'Liset' | 1.0 | 0.6 |
| 'Mary Potter' | 1.0 | 0.6 |
| 'Molten Lava' | 1.6 | 1.0 |
| 'Ormiston Roy' | 1.0 | 0.0 |
| 'Prairifire' | 0.0 | 0.0 |
| 'Professor Sprenger' | 1.6 | 0.3 |
| 'Profusion' | 2.3 | 2.3 |
| 'Radiant' | 3.0 | 2.6 |
| 'Ralph Shay' | 2.0 | 2.0 |
| 'Red Barron' | 3.0 | 2.0 |
| 'Red Jade' | 1.3 | 1.0 |
| 'Red Jewel' | 0.0 | 0.0 |
| 'Red Splendor' | 2.0 | 0.0 |
| 'Robinson' | 4.0 | 3.3 |
| 'Royalty' | 2.0 | 1.6 |
| 'Ruby Luster' | 3.0 | 2.0 |
| *M. sargentii* | 0.0 | 0.0 |
| 'Selkirk' | 2.0 | 0.6 |
| 'Sentinel' | 1.0 | 0.6 |
| 'Silver Moon' | 0.0 | 0.0 |
| 'Snowdrift' | 2.6 | 2.3 |
| 'Strawberry Parfait' | 0.0 | 0.3 |
| 'Sugar Tyme' | 1.0 | 1.3 |
| 'Velvet Pillar' | 2.6 | 3.0 |
| 'White Angel' | 0.0 | 0.0 |
| 'White Cascade' | 3.0 | 1.3 |
| 'Winter Gold' | 2.6 | 3.0 |
| *M. zumi* 'Calocarpa' | 1.6 | 0.3 |

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# Emergence, Longevity, and Aesthetic Evaluations of Flowers in Ornamental Crabapples at Secrest Arboretum in Wooster, Ohio: 1995

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## Abstract

Forty-six ornamental crabapple (*Malus spp.*) selections were evaluated for timing and duration of bloom. These selections were also appraised three times during the bloom period for aesthetic qualities of blossoms in addition to other factors that either enhanced or detracted from bloom. This study defined the reference bloom base of 'Dolgo' (the first crabapple to bloom) as zero, 0–3 days later as very early, early as 4–6 days, mid-season as 7–9 days, and late as 10+ days after reference bloom. Twenty-nine of the 46 selected crabapples retained their blooms at least 10 days or longer in 1995. 'Strawberry Parfait' had the most durable blossoms, lasting for 16 days, while 'Velvet Pillar' was the shortest at only five days.

## Introduction

Flowering crabapples (*Malus spp.*), as indicated by their common name, are most often planted in landscapes for their magnificent bud colors and floral displays during spring. If the sole emphasis is floral display then those crabapples whose flowers and buds are showy for an extended period of time should be of greatest value. Unfortunately, crabapple bloom is presently classified in loosely defined group designations of "early, mid-season, or late bloom" rather than periods of time. Also, if relative times of blossom emergence and longevity are known, then it is possible to create an extended continuous display of flowers by combining crabapples that flower at different times.

Den Boer (1) offered a method, Blossom Time Index, to describe the sequence of bloom. The sequence of bloom was categorized for all crabapples in reference to Manchurian crab, the earliest bloomer. All subsequent crabapple bloom emergence was based on number of days after the reference bloom. However, den Boer did not indicate longevity of bloom. Longevity of bloom is directly affected by environmental factors like wind, rain, high, and low temperatures. A combination of bloom emergence with relative time of effective blossom duration would be an extremely useful tool for assisting in landscape design decisions.

This study was initiated to determine relative times of blossom emergence and longevity that directly affect aesthetic qualities of ornamental crabapples.

## Materials and Methods

Forty-six selections of crabapples at the Ohio Agricultural Research and Development Center's Secrest Arboretum in Wooster, Ohio, were evaluated daily, 24 total times, from April 26, 1995, through May 20, 1995. Recorded observations for each crabapple included days of first blossom fully open, and the period

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when crabapples were past effective bloom display (50 percent or greater loss of overall blossoms).

Relative bloom times will be reported as indicated by den Boer (1) as days after bloom emergence for the earliest blooming crabapple, or reference base. The reference base for the Secrest plot was the crabapple 'Dolgo.'

Three aesthetic assessments were also conducted on April 29, May 6, and May 13, 1995. Subtleties such as early bud color, bud/leaf color complement, bud/flower contrasts, clear blossom colors or tints or lack of these aesthetic qualities were important aspects of these ratings. Other factors such as tree shape, mummifed fruit, and other components affecting aesthetics also influenced ratings. The assessment ratings were based on the following criteria:

1 = Exceptional ornamental crabapple. Based on outstanding foliage, flower, fruit, or form at time of rating.

2 = Highly ornamental crabapple. Good foliage, flower, fruit, or form at time of rating.

3 = Adequate as a landscape crabapple. Not highly ornamental at time of rating.

4 = Substandard as an ornamental crabapple at time of rating.

5 = Ornamentally unacceptable as a landscape crabapple at time of rating. Not recommended for use in the landscape.

These crabapple selections were planted in 1984, in a completely randomized block design with three replications of each selection. The cultural practices used to maintain the crabapple plot are minimal pruning, 6–8 foot diameter mulch ring of a 1–2 inch depth around each tree, and removal of rootstock suckers and dead branches, mimicking those cultural practices of an average landscape.

## Results and Discussion

The reference base crabapple, 'Dolgo,' first began blooming on April 26, 1995, and 17 days later, on May 13, 1995, 'Silver Moon' was the last to begin flowering in the plot. 'Strawberry Parfait' had the most durable flowers at 16 days and was spectacular in overall bloom aesthetics. Conversely, 'Velvet Pillar' flowered very late, offering blossoms for the shortest duration of five days and rated the poorest aesthetically.

For this study we defined the blossom times of very early as 0–3 days from reference bloomer ('Dolgo'), early as 4–6 days, mid-season as 7–9 days, and late as 10+ days. Three crabapples were very early bloomers, 11 were early bloomers, 19 were mid-season, and 13 were late bloomers (see Table 1).

Very early blooming crabapples averaged a blossom longevity time of 14 days, early bloomers duration averaged 12.5 days, mid-season bloomers duration averaged 10.5 days, and late bloomers blossom longevity averaged 8.5 days. Twenty-nine of the 46 selected crabapples retained their blooms at least 10 days or longer. A relatively mild winter and ideal spring weather possibly provided optimal conditions for maximizing bloom and longevity of blossoms.

The aesthetic ratings indicate many crabapples provide a highly ornamental floral display. Thirty-five of 46 crabapples received an average rating of 2.5 or better. Although many of the crabapples were highly ornamental at this point in time, it is but a brief moment relative to the length of the crabapple season. Therefore, to be most effective as a landscape component, other aesthetic characteristics, such as fruit display or disease profiles, must be known and scrutinized (2,3,4,5).

The top 12 aesthetically rated crabapples during bloom were 'David,' *M. halliana* 'Parkmanii,' 'White Cascade,' 'Bob White,' 'Mary Potter,' 'Sugar Tyme,' *M. zumi* 'Calocarpa,' 'Donald Wyman,' *M. floribunda*, 'Molten Lava,' 'Sentinel,' and 'Strawberry Parfait.'

Selecting crabapples with high aesthetic ratings and combining blossom emergence with bloom longevity makes it possible to create a flowering impact in the landscape for as long as three weeks. Ideally, choosing crabapples that flower about one week apart would result in the longest floral display.

However, the use of ornamental crabapples solely as flowering trees without recognizing other aesthetic characteristics, positive or negative, which crabapples create, can seriously detract from or greatly enhance the landscape.

It must be noted that these observations are limited to one site, Secrest Arboretum in Wooster, Ohio, and are for one year only. Other limitations of this study include preferential biases that may influence evaluators, the inability to maintain equivalent weather conditions throughout the blossom period, and lack of environmental modifications to reduce tree stress cycles that can affect bloom.

Table 1. Days from Reference Base, Duration of Bloom, and Aesthetic Ratings of Selected Crabapples

| Aesthetic Crabapple Rating | Days from Ref. Base | Days of Bloom | Aesthetic Rating |
|---|---|---|---|
| **Very Early** | | | |
| 'Dolgo' | 0 | 13 | 2.8 |
| *M. baccata* 'Jackii' | 3 | 13 | 2.4 |
| 'Strawberry Parfait' | 3 | 16 | 1.5 |
| **Early** | | | |
| 'Beverly' | 4 | 12 | 2.0 |
| 'Indian Summer' | 4 | 14 | 2.0 |
| 'Red Splendor' | 4 | 14 | 2.0 |
| 'Selkirk' | 4 | 11 | 2.0 |
| 'Jewelberry' | 5 | 13 | 2.2 |
| 'Ralph Shay' | 5 | 12 | 2.0 |
| 'Candied Apple' | 6 | 11 | 2.0 |
| *M. floribunda* | 6 | 12 | 1.3 |
| *M. halliana* 'Parkmanii' | 6 | 14 | 1.0 |
| 'Ormiston Roy' | 6 | 12 | 1.8 |
| 'Ruby Luster' | 6 | 13 | 3.0 |
| **Mid-Season** | | | |
| *M. adstringens* 'Hopa' | 7 | 7 | 2.7 |
| 'Radiant' | 7 | 11 | 3.0 |
| 'Sentinel' | 7 | 11 | 1.4 |
| 'Bob White' | 8 | 13 | 1.1 |
| 'David' | 8 | 13 | 1.0 |
| 'Red Jade' | 8 | 11 | 1.8 |
| 'Sugar Tyme' | 8 | 10 | 1.2 |
| 'White Cascade' | 8 | 11 | 1.0 |
| 'Adams' | 9 | 8 | 2.5 |
| 'Centurion' | 9 | 9 | 1.8 |
| 'Henningii' | 9 | 10 | 1.7 |
| 'Indian Magic' | 9 | 9 | 1.7 |
| 'Liset' | 9 | 13 | 2.1 |
| 'Professor Sprenger' | 9 | 10 | 1.8 |
| 'Red Barron' | 9 | 9 | 3.0 |
| 'Royalty' | 9 | 9 | 3.8 |
| 'White Angel' | 9 | 11 | 2.3 |
| 'Winter Gold' | 9 | 13 | 3.0 |
| *M. zumi* 'Calocarpa' | 9 | 12 | 1.2 |
| **Late** | | | |
| 'Donald Wyman' | 10 | 12 | 1.3 |
| 'Profusion' | 10 | 7 | 2.4 |
| 'Robinson' | 10 | 8 | 2.3 |
| 'Snowdrift' | 10 | 9 | 1.5 |
| 'Molten Lava' | 11 | 8 | 1.3 |
| 'Red Jewel' | 11 | 11 | 2.3 |
| 'Harvest Gold' | 13 | 9 | 2.9 |
| 'Madonna' | 13 | 9 | 3.0 |
| 'Mary Potter' | 13 | 9 | 1.1 |
| 'Prairifire' | 13 | 9 | 1.9 |
| *M. sargentii* | 14 | 8 | 2.1 |
| 'Velvet Pillar' | 14 | 5 | 4.4 |
| 'Silver Moon' | 17 | 6 | 3.2 |

1 = Exceptional ornamental crabapple. Based on outstanding foliage, flower, fruit, or form at time of rating.

2 = Highly ornamental crabapple. Good foliage, flower, fruit, or form at time of rating.

3 = Adequate as a landscape crabapple. Not highly ornamental at time of rating.

4 = Substandard as an ornamental crabapple at time of rating.

5 = Ornamentally unacceptable as a landscape crabapple at time of rating. Not recommended for use in the landscape.

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# Environmental and Cultural Ornamental Plant Problems in Ohio: 1995

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The following is a compilation of note-worthy environmental and cultural plant problems for 1995. Observations were drawn from information provided in Ohio State University's *Buckeye Yard and Garden Line* (*BYGL*) reports, Plant and Pest Diagnostic Clinic samples (PPDC), David J. Shetlar's *P.E.S.T. Newsletter*, and reports from the Ohio Department of Natural Resources Monthly Water Inventory Report for Ohio.

## Weather Background

Spring rains across much of Ohio helped to relieve some of the soil moisture deficits from a dry fall in 1994. Rain levels varied; by late May, Cincinnati was approximately 3" above normal for the year, while northern parts of the state remained dry. A warm period in mid-March resulted in temperatures in the 70s in parts of the state, followed by record lows on the night of April 4.

Temperatures moderated through May and June. Heavy rain episodes continued in parts of the state through June. At the end of the month, only the northeast and north central counties of the state were slightly below normal for the year. Rainfall totals for the rest of the state were near normal for the month.

Precipitation in July fell in the typical summer fashion as scattered showers and thunderstorms. Several storms were locally severe with heavy downpours, contributing to local urban and small stream flooding. Temperatures were above normal in July and August, reaching into the 90s.

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Rainfall in the first 20 days of August resulted from the remnants of southern tropical storms that delivered heavy rain across parts of Ohio. Regional averages for the month ranged from nearly 6" above normal in the west central region to about an inch below normal for the northeast region. Overall, the state was 125 percent of normal for rainfall in August.

The last 10 days of August were essentially dry. Those soils that were saturated at mid-month were rather dry by the end of the month, due to 10 days or more without rain, coupled with temperatures in the 90s. By the end of August, the Ohio Agriculture Statistics Service reported that 41 percent of the state had adequate soil moisture, and 59 percent had soils short of moisture. September remained dry across much of the state.

## Cold Damage

On the night of April 4, temperatures dropped to 15° F in Akron, 23° F in Cleveland, 18° F in Columbus, 17° F in Dayton, and 21° F in Cincinnati. Significant plant damage was reported across the state. Tip burn was noted on wintercreeper euonymus (*Euonymus fortunei*) and more intense foliar discoloration was noted on Japanese euonymus (*Euonymus japonicus*) and 'Wintergreen' boxwood (*Buxus microphylla* 'Wintergreen') in southern Ohio. Fully-open flowers of star and saucer magnolia were killed in southern and central Ohio; tipburn of petals on flowers in the bud stage was reported in northern Ohio. Forsythia flower quality was lessened in many locations where full flowering had taken place before the freeze. Flower damage to weeping cherry and other Prunus also in bloom in southern Ohio was noted. Nurseries and garden centers reported bud and

tip damage to newly-shipped west coast materials such as boxwood and spruce.

Reports of suspected damage to plants from the winter of 1993–1994 continued. Interior stem discoloration due to stem cracks, presumably from the deep freeze of January 1994, was observed. Cultivar differences were noted. In *BYGL* 95-20, 9-7-95, it was reported that in a nursery visit, *Acer rubrum* 'Red Sunset' red maple looked fine; *Acer rubrum* 'Schlesingeri' had stem splits, many unhealed, that extended as much as 10 feet and longer on the trunks. Many of the trees had cracked and had fallen over at weak points during the preceding year and a half.

## Cultural and Planting Problems

Extension agents and state specialists continue to receive calls regarding plant problems resulting from improper transplanting and post-transplant care. There were reports of plants being planted too deeply, mulched too heavily, watered improperly, and improperly sited, leading to eventual decline and death of the plant.

Lawn weed problems were prevalent during 1995. Although exact causes are subject to speculation, some theories were postulated. In areas of excessive rainfall, preemergent materials may have been leached. In dry areas, preemergent materials that were insufficiently irrigated may not have activated. Furthermore, weather conditions were excellent for germination of crabgrass and other weeds.

Problems continued to be reported on burning bush (*Euonymus alatus*). These included nearly complete defoliation and discoloration of leaves associated with severe spider mite infestations as well as environmental problems. In *BYGL* 95-20, 8-17-95, the following report was made — quoting the *Illinois Home, Yard and Garden Newsletter* No. 16 — and well described what we were also seeing in Ohio:

"The Plant Clinic has received a number of samples and calls concerning the rapid decline of burning bush plants. The samples have been examined for possible fungal canker problems, crown gall at the base of the plants, root injury and the like; but infectious problems do not appear to be at fault.

"The problem, then, may be root stress or root injury caused by moisture and temperature stress. These are not factors we can prove. We cannot find an infectious cause, and the problem is dispersed over a great geographic area, so the most logical cause is environmental stress."

## Fungus Problems on Mulches

Inquiries about artillery or shotgun fungus (*Sphaerobolus stellatus*) were common throughout the state. This fungus develops in decaying organic matter (such as mulch) and is typically noted in the spring and fall, when conditions are cool and moist. Tiny black specks, resembling insect feces at first glance, are actually mature spore masses expelled from fruiting bodies of the fungus. Spores have been found as high as the second floor of buildings. The specks, 1-2 mm in size, are difficult to remove from surfaces.

# 1995 — A Challenging Year for Ohio Golf Courses

Joseph W. Rimelspach, John R. Street, Karl Danneberger, William E. Pound, Barbara Bloetscher

The 1995 growing season was a difficult turfgrass maintenance season for golf course superintendents and other turfgrass managers throughout the Midwest. The Ohio State University Plant and Pest Diagnostic Clinic received numerous turf samples from Ohio and surrounding areas. Ohio State faculty and staff received more telephone calls and requests for on-site visits than any other summer in recent history. A major factor influencing turfgrass health on golf courses this year was the extreme environmental conditions. There is nothing more frustrating for golf course superintendents or turfgrass managers than to have to deal with adverse weather that is out of their control. This year presented some dramatic abnormal weather patterns that had tremendous impact on turfgrass growth and performance.

## Environmental Impact

The environment during the spring and summer of 1995 was very conducive to extreme plant stress, turfgrass diseases, and turfgrass decline. It was one of the worst summers on record for growing high quality turf under the intense management of the golf course.

It is important to realize that the types of grasses used on golf courses in all of Ohio and the Midwest are cool-season grasses. Cool-season grasses, as the name implies, grow and prosper best under cool moist conditions of spring and fall. Shoots and leaves (tops) grow best at temperatures of 60–75° F. Roots of cool-season grasses grow best at soil temperatures of 55–65°F. Air and soil temperatures this summer far exceeded these ideal ranges for extended periods of time.

Turfgrass types in the cool-season group include creeping bentgrass, Kentucky bluegrass, ryegrass, fescue, and annual bluegrass (*Poa annua*). These turfgrasses develop a dense, healthy plant community with a deep prolific root system in the cool periods of the year. The latter development is imperative for turfgrasses to form resistance to environmental and cultural stresses and disease pathogens that are encountered in summer.

### Spring Conditions

The spring of 1995 was cool but wet in most of the state. Rainfall records were set in many areas. Although the shoots and leaves (tops) of the turf looked green and lush, and playability was good to excellent, the turfgrass root system was actually declining, with wet saturated soils resulting in short roots with a significant loss of root mass. Root systems on golf courses with good drainage and well-built greens developed better than on poorly drained greens.

### Summer Heat and Humidity

Perhaps the most devastating environmental blow was the summer heat and humidity. Summer conditions did vary somewhat throughout the state, but in general temperatures were very hot and humidity was consistently high.

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For much of July and August, daytime temperatures were 90° F or higher, and nighttime temperatures were 70° F or higher. Nighttime temperatures on many nights remained in the high 80s until midnight or later. Particularly unusual and oppressive this summer was the number of consecutive days of high daytime and nighttime temperatures. In many cases, these high temperatures lasted more than six weeks.

Normally, hot periods in the summer are interspersed with cold fronts that bring several days of cool weather to assist in turf recovery. These intermittent periods of cool weather coupled with usually cooler nights throughout the summer are critical to the overall health and survival of cool-season turfgrasses. Hot humid days and nights provided no relief for turfgrasses in July and August.

## Weakened Turfgrasses

High temperatures placed an extreme physiological stress on cool-season turfgrasses. First, photosynthesis (food production) slows as temperatures increase into the high 80s and 90s and is drastically reduced as temperatures approach 100° F. Respiration (utilization of food reserves) increases as temperatures increase.

High day and night temperatures in July and August resulted in high rates of respiration. As a result of low photosynthesis and high respiration, available food in the turfgrass plant was depleted. Under this scenario, day by day the turfgrass plant continued to weaken.

Annual bluegrass (*Poa annua*) was the cool-season grass most affected by these extreme weather conditions. It is considered to be the least tolerant of the cool-season grasses to heat and stress. Golf courses with high populations of annual bluegrass had extensive damage.

## Soil Temperatures

Soil temperatures at the 1- to 2-inch soil depth (i.e., where most of the roots existed this summer) were often only a few degrees lower than air temperatures. Temperatures in the turfgrass canopy were usually higher than air temperatures. At midday, soil temperatures were often measured at 100° F or above, especially on sand greens.

Optimum soil temperatures for root growth of cool-season grasses are 55–65° F. It is not surprising that turfgrass roots began to die back. Bentgrass will not initiate new roots when soil temperatures exceed 90° F. High soil temperatures resulted in root decline and no opportunity for root regrowth and recovery.

Turfgrass plants with deteriorating root systems became extremely susceptible to disease and stress. Weakened plants recovered poorly even where excellent fungicide programs were being used.

## Excess Water

Excessive soil moisture occurred throughout many parts of the state. With heavy rainfall, oxygen level was reduced in the soil, suffocating roots. Waterlogged soil coupled with high temperatures caused rapid and extensive root dieback and death. In many cases, superintendents can pinpoint a specific day or time period that was the breaking point for turfgrass on their course.

Wet conditions also promoted algal growth on the soil surface that spread to leaf surfaces. This contributed to turf thinning and decline. Algae that formed on the soil surface were difficult to break up, and further slowed soil drying.

## Rapid Water Loss

In late August, daytime temperatures remained high, relative humidity decreased, and winds increased causing extensive evaporation of water from turfgrasses. With a very shallow root system, the turfgrass plant rapidly lost water, wilted, and declined.

Due to these weather patterns, turf roots on many greens and fairways became short and stunted resulting in a fragile plant system. This turf continued to thin despite cultural and chemical attempts to revive it.

## Disease Management

The high temperatures, high relative humidity, and wet conditions experienced this summer favored the development and spread of serious disease problems such as brown patch (*Rhizoctonia solani*), pythium blight (*Pythium* spp.), summer patch (*Magnaporthe poae*), anthracnose (*Colletotrichum graminicola*), take-all patch (*Gaeumannomyces graminis*), and others.

Brown patch (*Rhizoctonia solani*) grows ideally when night temperatures exceed 68$^0$ F combined with high humidity and wet foliage. This disease is common on all cool season grasses and can cause extensive thinning, browning, and deterioration of turf.

Pythium blight (*Pythium spp.*) is often feared more than any other disease by the golf course industry because when weather conditions are conducive for Pythium development, it can actually kill turf within a matter of one day or less. Weather conditions that are ideal for this disease are night temperatures above 70° F, day temperatures at or above 90° F, high humidity, and abundant moisture. Under wet conditions the disease can spread rapidly, resulting in large areas of dead turf.

Another important feature of disease management is correct diagnosis. In a year such as this, it is difficult to sort out all the factors resulting in brown grass as there are many confusing symptoms. The interaction of disease activity, weather stress, and damage from traffic was extensive.

Monitoring the weather and knowing the most likely sites for disease development on the golf course are key factors used in timing and planning fungicide strategies. Once a disease is active, fungicide applications to stop the progress are often ineffective. With many of these diseases a preventative fungicide program is critical for successful management.

## Turfgrass Use

Upon evaluating golf courses throughout the state, the amount of play was directly correlated with success or failure. Golf courses with high use (i.e., especially public golf courses) had more turf loss. Many courses only suspended play during the time of actual thunderstorm or rain shower activity. If play was resumed shortly after rain under wet conditions, extensive damage occurred. Play on heat stressed or wilted turf also caused damage.

Turf was also damaged where golf carts and maintenance equipment were repeatedly driven. If the soils were wet, compaction and turf injury increased. In situations where the turf and soil were dry, the crowns were often injured. Tire tracks led to unusual symptom patterns and extensive damage to turf, especially in fairways.

Some golf courses have tournaments or special events at various times throughout the year. To prepare for these, greens were often cut lower and more frequently to increase ball speed. If these maintenance practices were performed during the hot stress period, the already fragile turf was seriously weakened. In a number of instances, these events occurred around the fourth of July; and for the next two months, turf had no opportunity to recover. These golf courses struggled with serious problems throughout the rest of the summer.

Green size was another factor influencing success or failure. In general, courses that had larger greens, where pin placements were spaced out and wear was distributed over a larger area, survived much better than smaller greens.

## Course Expectations

Most golf course superintendents respond to the golfer's desire for faster greens. This is often accomplished by lower mowing heights, more frequent mowing, rolling, frequent topdressing, and related activities. All these factors place additional stress on the turfgrass plant. In most years these practices can be performed and turf maintained. There was little opportunity this year for turf recovery. If anything further weakened the turf, it declined or developed serious problems.

In most instances where golf courses maintained high quality turf throughout this summer, some significant alterations were made in mowing practices. First, mower height was raised early before the onset of heat. Second, grooming rollers were replaced with smooth rollers on greens mowers. Again, these practices were instituted before adverse weather and disease weakened the turf. Third, superintendents switched from riding greens mowers to walk behind greens mowers. Complaints were received by superintendents about slower greens; however, turf was maintained more successfully throughout much of the summer.

It must be pointed out that mowing height plays a dominant role in the health and vigor of turfgrasses. Allowing more leaf area to remain results in more food produced for the plant. In fact, only a small increase in mowing height (i.e., 1/16 to 1/32 inch) can have a significant impact on reducing turf stress. Also, slightly higher mowing heights will increase rooting depth and mass. Greens speed may have to be sacrificed for the overall betterment of turf and playability under extreme environmental conditions.

## Water Management

The first element of water management is proper drainage. Proper drainage includes both surface and internal soil drainage. Golf courses with low areas on greens or fairways had much more damage than courses that were designed with good surface drainage. Courses that had inadequate soil drainage had serious problems managing water and disease problems.

The second element of water management is irrigation system design and management. Many golf courses showed inadequacies in the present irrigation system either due to poor design or operation problems. As a result, certain areas of the course were too wet while others were too dry.

Syringing is a practice of supplying light amounts of water to turf. This is used to prevent wilt of turf during hot and dry periods and to cool turf under hot conditions. In Ohio, depending on the summer, syringing may be used occasionally to quite frequently. This year, syringing had to be used extensively to cool turf.

The challenge in many cases is to syringe turf with saturated soil without adding to the existing moisture problem. There was little option but to apply water to cool the turf and keep it alive.

## Conclusion

Managing turfgrasses in the summer of 1995 was a complex and challenging job. Many different factors interacted to cause turfgrass decline and failure on golf courses.

Weather played a dominant role. In short, excessive rainfall, oppressive day and night temperatures, and humidity gradually produced weakened turfgrass plants. These plants become vulnerable to disease and environmental/cultural stresses causing turf decline.

Turfgrass plants became so weak that they lacked enough vigor to respond to even the best programmed pesticide and fertilizer applications by golf course superintendents.

Managing fragile grass during a summer as severe as 1995 demands a reduction in cultural stresses, a thorough knowledge of turfgrass science, and cooperation between the superintendent, golf club owners, and members. The 1995 season presented an opportunity to learn and plan for the future.

# Plant Insect Pest Problems in Ohio: 1995

Joseph F. Boggs, David J. Shetlar, Gary Yu Gao, Daniel Balser, Douglas C. Caldwell, Randall H. Zondag, and James A. Chatfield

The following is a collection of notable plant insect pest problems observed in Ohio during the 1995 growing season. The information was based on reports made in the Ohio State University Extension's *Buckeye Yard and Garden Line* (*BYGL*), in David J. Shetlar's *Pest Evaluation and Suppression Techniques (P.E.S.T.) Newsletter*, and on other observations.

## The Weather

Weather conditions can have a significant effect on insect development, pest population levels, and pest/host relationships. From Dave Shetlar's *P.E.S.T.* summary for the year comes this observation:

"We came into the spring after a fairly mild winter but someone forgot to turn off the rain in May, June, and early July. Rain in the southern two-thirds of Ohio caused soils to become saturated and the roots of plants (whether trees, shrubs, or turf) were severely damaged. [Parts of] Northern Ohio got a drought.

"In mid-July, the faucet was abruptly turned off in some areas. However, hot humid conditions continued throughout August and early September. [Turf, trees, and shrubs] didn't have a very good root system in mid-July, and many plants couldn't survive the drought without roots. The result — disease, borers, and grubs had their way with the plants."

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## Plant Stress and Borers

Infestations of beetles which bore beneath bark or into wood were commonly reported this season. Such infestations have long been associated with plant stress. For example, the Columbian timber beetle (*Corthylus columbianus*) was found excavating oviposition tunnels in the limbs and main trunks of bigleaf magnolias in southern Ohio. This bark beetle was considered a secondary problem — the magnolias were suspected of having Verticillium wilt disease.

Honeylocust trees came under heavy attack this season from honeylocust plant bug (*Diaphnocoris chlorionis*), potato leafhopper (*Empoasca fabae*), mimosa webworm (*Homadaula anisocentra*), and the honeylocust spider mite (*Eotetranychus multidigituli*). The onslaught caused concern regarding increased risk of infestation by the honeylocust borer (*Agrilis difficilis*). Dave Shetlar noted in *BYGL* 95-11:

"Trees subjected to stress-causing factors, such as heavy [insect] feeding, are more susceptible to attack by borers. Therefore, to protect damaged honeylocusts from borers, arborists may consider making an application of an EC formulation of chlorpyrifos (e.g., Dursban). Applications should be made to trunks and special attention should be given to recently planted honeylocusts."

This form of preventive application was also recommended for control of twolined chestnut borer (*Agrilis bilineatus*) in recently planted oaks. From *BYGL* 95-8: "This application should be done the first two years after plant-

ing and is more critical on trees that are in high profile areas and are suffering from planting-induced stress."

Bark beetles did not spare conifers this season. Dave Shetlar noted in his *P.E.S.T.* summary: "Conifer bark beetles also continued to make use of stressed pines, spruces, and white cedar. Of course, again, the real problem was root rots and poor growth due to excessively wet and dry soils as well as fungal diseases. When these agents weaken the tree, it becomes defenseless because it can not muster enough sap to gum up a borer trying to enter through the bark. Unfortunately, when these bark beetles attack, the plant is probably history. Surrounding conifers should be evaluated for their health — color and amount of growth. If they are also showing signs of stress, protectant bark sprays may be warranted in mid-May and again in mid-July, the time that most conifer bark beetle adults are searching for stressed trees. Use lindane or chlorpyrifos (=Dursban)."

## Caterpillar Catalog

Gregarious-feeding caterpillars, such as the yellownecked caterpillar (*Datana ministra*), walnut caterpillar (*D. integerrima*), and the hickory tussock moth (*Lophocampa caryae*) were common throughout Ohio. However, no serious outbreaks were reported.

Large solitary-feeding caterpillars were also common, and some provided exciting human encounters. One of the most impressive looking (and named) is the hickory horned devil (= regal moth) (*Citheronia regalis*). Measuring 4–6 inches in length, this aggressive, hairless, blue-green caterpillar has long, curved, orange spines (with black tips) on the first two thoracic segments and three to four shorter black spines on the top of each additional segment.

Its common name comes from its preferred host — hickory — and from its behavior. When disturbed, the devil whips its head and thorax around, giving the convincing impression that it is trying to impale the offending irritant. The caterpillar also feeds on sumac, sweet gum, and walnut.

## Disappearing Caterpillars

Populations of yellow jackets (*Vespula sp.*) were unusually high in several areas of the state this year. It was noted that caterpillars such as the yellownecked caterpillar and fall webworm (*Hyphantria cunea*) seemed to be vanishing in areas where yellow jackets were most numerous. Yellow jackets were observed "picking off" these caterpillars and thus appeared to be orchestrating the caterpillar disappearing act. Where yellow jacket populations were low, caterpillars remained quite noticeable.

## Leafminers

The locust leafminer (*Odontota dorsalis*) ravaged black locust leaves throughout Ohio. The digitate mines produced by the larvae, coupled with the skeletonized leaves produced by the adults, caused many trees to become completely brown. Birch leafminer (*Fenusa pusilla*) was common, but populations appeared to be lower than last year.

## Spider Mites

In Dave Shetlar's *P.E.S.T.* summary, he reports: "Spider mite activity was also 'interesting' this year. The spruce spider mite (*Oligonychus ununguis*) was apparently washed from its conifer hosts in June and July, but it is making up for lost time this fall. The twospotted spider mite (*Tetranychus urticae*) was relatively uncommon, possibly because of fungal diseases early in June. However, the honeylocust mite and the oak mite (*Oligonychus bicolor*) were very plentiful by mid-August and they caused leaves to turn orange and bronze."

## Lacebugs

Lacebug populations developed slowly this year due to heavy rains in the spring and early summer. However, once rains subsided in July, populations expanded rapidly. Damage was noted on azalea, rhododendron, cotoneaster, and amelanchier with the heaviest injury occurring on hawthorn and oak.

By mid-August, the oak lacebug (*Corythuca arcuata*) had stippled leaves on bur and chestnut oaks in southwest Ohio almost to the point of transparency. At about the same time, similar damage produced by the hawthorn lacebug (*C. cydoniae*) was observed on hawthorns in northeast Ohio.

## Sawflies

European pine sawfly (*Neodiprion sertifer*) made an unusually early spring appearance on hard pines in southern Ohio. Eggs hatched in early April. Last year, egg hatch did not occur until late April for central and southern Ohio. The early appearance was attributed to the uncommonly mild winter.

Redheaded pine sawfly (*N. lecontei*) made its usual appearance in mid to late summer and white pine sawfly (*N. pinetum*) came on the scene in early to mid-fall. Although all three sawflies were common, populations appeared to be lower this year.

## Making a Comeback

After being frozen out during the winter of 1993-1994, bagworm (*Thyridopteryx ephemeraeformis*) made a comeback this season. From Columbus south, this pest was common on junipers, white pine, spruces, and a variety of broadleaf trees.

## A Periodical Problem

Although the last brood of the periodical cicada, or 17-year cicada (*Magicicada septendecum*), emerged several years ago in Ohio, branches are still succumbing to the old slit-like oviposition scars produced by females of this insect. Leaves were observed wilting and turning brown this season on heavily scarred branches of several deciduous trees including birch, oak, and hickory. Expression of symptoms so long after the injury has occurred can present a serious diagnostic challenge.

## Division of Forestry Reports

Dan Balser of the Ohio Department of Natural Resources (ODNR) Division of Forestry summarized a number of reports from ODNR foresters throughout Ohio. These included defoliation of 30 acres of trees by the cherry scallop shell moth (*Hydria prunivorata*) in Columbiana County, reports of beech scale (*Cryptococcus fagisuga*) on American beech in northeast and eastern Ohio, heavy cottony maple scale (*Pulvinaria innumerabilis*) infestations at several urban sites on silver maple, lighter pear thrips (*Taeniothrips inconsequens*) damage on maples than in recent years, and heavier pine bark adelgid (*Pineus strobi*) infestations than usual reported from northern Ohio.

## One More Scale

Doug Caldwell of Davey Tree notes that several lecanium scale species (such as *Parthenolecanium corni*) developed very heavy populations in northeastern Ohio on a number of hosts, including oak, sweetgum, and maple. Doug waxed poetic, describing the massive overlapping infestations thusly: "Like barnacles on the hull of a ship, complete with ghost rain and sooty mold."

## White Grubs

Grub reports were made in nine of the 27 *BYGL*s this year — it was an interesting grub season. The *BYGL* season led off with a report in *BYGL* 95-1 concerning the efficacy (or lack thereof) of spring grub applications:

"Dave Shetlar indicated that spring applications are generally not recommended for Ohio: Overwintered Japanese beetle (*Popillia japonica*) and northern masked chafer (*Cyclocephala borealis*) grubs move up and down in the soil profile making exposure to insecticides inconsistent; grubs are large (Chuck Behnke, Lorain County calls them "Bubba Grubs") making them more difficult to kill; overwintered grubs cause little damage — most damage occurs in the fall. Dave noted that spring applications seldom have more than a 50 percent efficacy rate."

Japanese beetle adult emergence proceeded slowly this year due to delayed larval and pupal development this spring. Developmental

rates were prolonged because of the extended cool weather conditions. Consequently, adult feeding activity — and the accompanying damage — occurred over an extended period of time. For example, Dan Balser (Ohio Department of Natural Resources) reported in the August 24, 1995, *BYGL* (*BYGL* 95-21) that skeletonized basswood leaves in northwest Ohio were just beginning to turn brown.

Although adult emergence was prolonged, the timing for white grub control applications was not radically affected. The grub control application window opened around mid-August. Dave Shetlar reported in *BYGL* 95-19 (August 10, 1995): "Japanese beetle larvae (grubs) are in the late first instar stage, and northern masked chafer larvae have reached the early second instar stage in central Ohio. Although adults of both beetles are still being seen, the majority of the eggs for this season have been laid. This means that NOW is an ideal time to make grub applications in southern and central Ohio. Next week will be ideal for northern Ohio."

Challenges associated with differentiating white grubs from other root-feeding insects, such as black vine weevil (*Otiorhyncus sulcatus*), in nurseries and landscaping was of particular concern this season. For example, the following is from a *BYGL*-25 report titled, "Grubs or Black Vine Weevil Larvae?"

"Randy Zondag reported serious grub problems in landscaping and containerized nursery stock. Although grubs are often only considered in relation to turf, Dave Shetlar pointed out that Asiatic garden beetle (*Maladera castanea*), Oriental beetle (*Anomala orientalis*), and European chafer (*Rhizotrogus majalis*) grubs can do very well on the roots of woody ornamentals. Currently, these beetles are found only in Northeast Ohio.

"Root feeding by these grubs produces damage which is very similar to that caused by black vine weevil (BVW) larvae. Also, BVW larvae are 'grub-like' and can currently be found feeding on roots. However, control strategies for BVW and the grub-producing beetles differ (see OSU Extension Fact Sheet 1026-88, 'Black Vine Weevil and Its Control.' Thus, grub identification is very important. BVW larvae do not have a discernible raster pattern on the underside of the tip of the abdomen. The Asiatic garden beetle, Oriental beetle, and European chafer beetle grubs do have raster patterns and this feature is used to identify the grubs. Refer to OSU Extension Fact Sheet HYG 2510-94, 'Identification of White Grubs in Turfgrass' for diagrams of the raster patterns."

## Red Spiders, Red Queens, and Second Opinions

Both the *BYGL* and *P.E.S.T. Newsletter* are dedicated to helping diagnosticians arrive at correct identifications of plant problems. Correct diagnoses are central to selecting the proper course of action. The following report made in *BYGL* 95-12 illustrates this point as well as the importance of seeking help from a trained horticulturist in correcting an incorrect diagnosis:

"Erik Draper of OSU Extension–Mahoning County reported receiving a phone call from a homeowner asking for a second opinion. They had recently been told that their large white pine tree should be removed because of 'red spiders.' Although no such critters exist as a plant pest, it is a name that is sometimes invoked (in ignorance?) in an effort to convince homeowners that questionable work should be done. However, this homeowner had not been convinced and had disagreed with the recommendation.

"So, in a burst of creative diagnostic deception, the landscaper had also shown the homeowner a 'red queen' extracted from its loathsome lair — a frothy mass of spittle. Although the immature pine spittlebug (*Aphrophora parallela*) was incapable of producing 'red spiders,' its repulsive appearance and lifestyle caused the homeowner to waver. However, before the work was approved, Erik was consulted and the value of a second opinion (and of Extension) was once again demonstrated."

# Gypsy Moth in Ohio: 1995

Allen Baumgard, David F. James, and Randall H. Zondag

Gypsy moth *(Lymantria dispar)* is potentially one of the most destructive pests in forests and surrounding plantings in Ohio. Large populations of the larval or caterpillar stage of this pest can completely defoliate trees.

Gypsy moths were introduced into the United States in 1869 to cross with the silkworm. A population escaped from the laboratory and continues to spread across the northeastern states as far west as Ohio, Michigan, and even into Wisconsin. Populations in Ohio continue to build, moving from the northeast counties to the south and west. Populations are also moving into northwest Ohio from Michigan.

Gypsy moth populations tend to build and decline over a seven- to 10-year cycle, depending on the weather and predator populations. In the first few years of the cycle, the pest does little visible damage but adds numbers to its population.

In the latter years of the cycle, populations become large enough to cause total defoliation in certain species before the population collapses. Total defoliation of certain trees over a period of years makes them susceptible to stress pathogens, other insect problems, and environmental problems. Because the defoliation occurs so early in the growing season (May and June), many trees never store enough food reserves to develop in the following years.

The most desired species for gypsy moth feeding include alder, apple, aspen, basswood, birch, boxwood, hawthorn, larch, mountain ash, oak, spruce, sumac, willow, and witch hazel.

In 1995, acreage of defoliated trees in Ohio jumped from 100 acres (in 1994) to 14,401 acres. The harsh winter of 1994 followed by the mild winter of 1995 apparently favored gypsy moth population growth. Major defoliation occurred in Ashtabula, Carroll, Columbiana, Geauga, Jefferson, Lake, Mahoning, Portage, and Trumbull Counties.

The 1995 season was the sixth straight year that acreage treated for gypsy moth by the Ohio Department of Agriculture increased. A total of 7,220 acres were treated for population suppression, and 286 acres were treated for educational purposes in 1995.

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Allen Baumgard, Ohio Department of Agriculture; David F. James, Ohio State University Extension–Trumbull County; and Randall H. Zondag, Ohio State University Extension–Lake County

# Landscape Ornamental Disease Problems in Ohio: 1995

James A. Chatfield, Nancy Taylor, Randall H. Zondag, Mary Ann Rose, Gary Yu Gao, Daniel R. Balser, and David J. Shetlar

A compilation of noteworthy disease problems affecting landscape ornamental plants in Ohio during the 1995 season is presented here. These observations are drawn from information in The Ohio State University's *Buckeye Yard and Garden Line* (*BYGL*) reports, Plant and Pest Diagnostic Clinic (PPDC) samples, Dave Shetlar's *P.E.S.T. Newsletter*, reports of the Ohio Department of Natural Resources Division of Forestry, and other observations.

## Apple Scab

Apple scab on crabapple (caused by *Venturia inaequalis*), is a yearly occurrence on susceptible crabapple species and cultivars. Some years are worse than others, depending on environmental conditions. The spring of 1995 was just such a year in much of Ohio.

This spring was characterized by prolonged humid, wet, moderate-temperature weather, great conditions for primary infections (from spores produced on infected leaves on the ground from the 1994 season) and cycles of secondary infections (from spores produced on leaves infected this season).

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In some cases, symptoms were atypical — instead of roundish, scabby, discreet gray to olive-green spots on leaves, entire leaves quickly were covered by grayish fungal growth, with defoliation soon to follow. Fruit infections were also severe in some cases. On 'Candied Apple' crabapple at some Ohio locations, tiny fruits were covered with velvety green fungal growth by early June, robbing this cultivar of its namesake shiny red fruit color for the entire season.

The "sheet scab" this year on leaves was very difficult to prevent, simply because infection periods were back to back and protective sprays were difficult to apply during periods of near-constant rain. The best control for scab, of course, remains the planting of crabapples that have excellent to good resistance to the disease.

## Anthracnose Diseases

These diseases typically cause brownish, reddish-brown, or tannish-brown blotches along leaf veins. More serious twig and branch dieback can occur with two common anthracnose diseases — sycamore anthracnose and dogwood anthracnose.

• **Sycamore anthracnose** (Caused by *Apiognomonia veneta*). In both 1994 and 1995, cool wet conditions during leaf emergence in mid-spring resulted in predictably severe anthracnose on sycamore and to a lesser extent on London planetree. These trees do tend to re-leaf by the end of June, but heavy infestations in successive years may trigger stress problems such as invasion by ambrosia beetles.

• **Dogwood anthracnose** (Caused by *Discula destructiva.*) This disease is a serious problem in

heavily wooded forested areas in the southeastern and eastern United States, especially in upland sites, and in some landscape situations with dense shade and poor air movement.

Dogwood anthracnose does occur in Ohio; for example, the Ohio Department of Natural Resources confirms reports of it from nine counties in Ohio in 1995. In most Ohio landscapes, however, especially where flowering dogwood was planted in sites with partial shade, good air movement, moderate fertility, and proper mulching, dogwood anthracnose was not a major problem.

• **Ash anthracnose** (Caused by *Apiognomonia errabunda.*) Ash anthracnose was also quite prevalent in 1994 and 1995, thriving in the wet conditions of late May in many areas, resulting in considerable water soaked leaf spotting and leaf drop and tannish leaf blotching on leaves infected later. Generally, trees recovered well from ash anthracnose, although a number of other problems, such as ash decline, were widespread on ashes.

Several other relatively uncommon anthracnose diseases identified in Ohio in 1995 were elm anthracnose (pathogen unidentified) and beech anthracnose (*Discula* sp.).

## Powdery Mildew of Flowering Dogwood

Every dog has its day, but the increasing incidence of powdery mildew on flowering dogwood (caused by *Microsphaera* sp.) in Ohio, Kentucky, and other Midwestern states during the past few years is a great surprise to many plant pathologists and horticulturists. The symptoms of this powdery mildew disease are often diagnostic foolers at first to those unfamiliar with the disease.

Although typical powdery white colonies of mildew do develop eventually, other symptoms are often more noticeable, especially early in the infestations. As John Hartman of the University of Kentucky outlined in an early July 1995 *Kentucky Pest Newsletter*, dogwood powdery mildew is often characterized by symptoms of:

- Small dark red splotches on upper leaf surfaces which develop into brown dead areas.
- Yellow mottling and distortion of new leaves.
- Yellowing of older leaves.

The intensely humid weather this season may have contributed to repeated infections by this powdery mildew fungus.

## Fireblight

(Caused by *Erwinia amylovora.*) Bacterial fireblight is a common problem on plants in the rose family, such as crabapple, Callery pear, pyracantha, cotoneaster, mountain ash, and others, causing shoot dieback (and plant death on highly susceptible hosts). The 1995 season was no exception, as fireblight was widespread.

Incidence of fireblight depends to a great extent upon host susceptibility. For example, certain crabapples are much more susceptible than others. Severity also varies widely. For example, many Callery pears become infected, but the disease typically tends to spread only a matter of inches, rather than feet, back along the branch on this host.

Environmental conditions also play a role in fireblight infections. For example, the most common type of infection is blossom infections, although shoots, fruitlets, and spurs may also be infected. Blossom infection is favored by warm (over 60° F) humid conditions during flowering. This spring at Secrest Arboretum in Ohio these conditions were common during bloom of 'Harvest Gold' crabapple.

At Secrest, two 'Harvest Gold' replicates in the National Crabapple Evaluation plots flowered heavily while one did not. This crabapple has a tendency for alternate year blooming. The ones that flowered had literally hundreds of small

blighted shoots from these blossom infections, while the non-flowering 'Harvest Gold' exhibited no fireblight this year.

## Diplodia Tip Blight

This disease (caused by *Sphaeropsis sapinea*) continues to be a significant problem on stressed Scots, Austrian, mugo, red, and many other two- and three-needled pines, with occasional occurrences on white pine, spruce, and certain other conifers. Infections occur during development of new growth in spring, resulting in dieback of the new season's growth, and progressive branch dieback, typically moving upward in the tree from lower branches over the years.

Preventive fungicide controls are used in spring as new growth starts to develop. Cultural controls such as proper pruning, fertilization, proper site selection, and improved drainage are year-round propositions.

## Diseases of Herbaceous Annuals and Perennials

A greater awareness of these diseases is evident in the past few years, especially as perennials become more popular. In addition, the past two seasons have brought out the worst in terms of some of these diseases.

The occurrence of *Botrytis* gray mold (caused by *Botrytis cinerea*) on geranium and other annuals was severe in 1995 due to extended humid periods in much of the Midwest. Plants looked especially bad where deadheading was not used, as infected senescent blossoms fell onto leaves, resulting in messy infections of leaf tissues as well.

*Verticillium* wilt (caused by *Verticillium dahliae*) was identified in the Ohio State University Plant and Pest Diagnostic Clinic on several geranium samples.

Southern blight of hosta (caused by *Sclerotium rolfsii)* has caused problems in some Ohio landscapes in recent years of heavy moisture and humidity. This disease is evidenced by a fan-like white fungal mycelial growth over the infected leaf and crown tissue and eventually development of "mustard-seed" sized reddish brown hardened sclerotia of the fungus. This is fairly unusual in northern states on hosta, although a common problem in northern landscapes on ajuga, and very common on many ornamental plants in more southerly states.

## New Disease Reports for Ohio

Nancy Taylor of the Plant and Pest Diagnostic Clinic and Department of Plant Pathology Professor Emeritus Wayne Ellett reported several firsts for Ohio, now to be included in the *Ohio Plant Disease Index* by Dr. Ellett. These were:

• **Venturia blight of maple** (Caused by *Venturia acerina.*) Following is a description of this disease from Sinclair, Johnson, and Lyon's *Diseases of Trees and Shrubs*:

"Necrotic lesions up to [one inch] in diameter develop in mid-summer. The lesions are more or less round except where they are bounded by major veins or the leaf edge. On the upper surface they have deep reddish-brown centers and dark brown edges with diffuse margins. The lower surface is grayish green to grayish tan. Coalescing lesions kill large areas of leaf blades. Severe infection leads to premature reddening and casting of red maple leaves."

As indicated in *Diseases of Trees and Shrubs*, this is typically an "inconsequential leaf blight of maple," but as noted in *Buckeye Yard and Garden Line* 95-24, in this case it was "significant enough to apparently contribute to some early leaf drop for the past two years."

• **Verticillium Wilt of Ash** (Caused by *Verticillium dahliae.*) Although its presence has been suspected in Ohio, *Verticillium* wilt of ash had not been confirmed in Ohio until 1995. Initial symptoms included scorch of leaflets and leaf drop. On ash, the typical dark streaking of

vascular tissue often associated with *Verticillium* wilt diseases is not present and is not a diagnostic feature.

• **Rust on Switchgrass** (Caused by *Puccinia* sp.) Although ornamental grasses are often described as being disease-free, this rust disease was identified in Ohio in 1995.

## Unidentified Problems

Two problems that continue to baffle diagnosticians are the blackening of arborvitae foliage and the unusual distortion of the foliage on oaks in springtime. On the arborvitaes, speculation ranges from horticultural oil injury or damage from fertilizer contamination of oil applications to various root problems and winter injury symptoms. None of these seem to make sense for all of the instances of the foliar blackening.

With the oaks, speculations range from frost injury to growth-regulator herbicide injury to various insect problems. Again, none of these suspicions was confirmed or seemed to explain all instances of the problem.

## BYGLSpeak

At the conclusion of each week's *BYGL* in 1995 is a quote, sometimes inspirational, sometimes silly, generally related to horticulture. To conclude, here are a few BYGLSpeak entries for the past year.

First, from Mark Twain, a reminder that, though every year is unique, there are similarities. Sort of a "It's not one darn thing after another, it's the same darn thing over and over again" philosophy. As Samuel Clemens puts it: "The past may not repeat itself, but it sure does rhyme."

Second, from a modern day Twain, or perhaps a Jack Kerouac of the 90s, this from Ohio State University Extension–Lorain County's Charles Behnke in *BYGL* 95-10 on June 8:

"In Lorain County, cottonwood fluff is blowing in the wind. Cottony fuzz, tree lint for Mother Earth's navel. Sod webworm adults are fleeing from the Behnke mower/bug shredder. Spittlebugs are spitting, maple petiole borers are at work. That's it from the Behnke Estate."

# The Response of Native and Naturalized Trees to Construction Activity

T. Davis Sydnor, Joseph F. Boggs, and Mary Ann Rose

The American public has a love affair with trees. One manifestation of that love affair is the willingness of homeowners to pay 10 to 30 percent more for a wooded lot than a similar-sized lot in a similar subdivision lacking trees. The assumption by the general public is that trees are indestructible. Surprise, surprise!

Various tree species respond differently to construction. One sad situation occurred when a property owner bought a wooded lot and snaked the house among the trees. The trees were killed by the construction activity. The homeowner then had to pay to have the trees cabled down since the dead trees towered over the new residence. The homeowner ended up with a serpentine home on an open lot.

Trees, unlike animals, cannot move. As a consequence, a tree must adapt to the changes that occur during construction. Some trees are better at this than others.

The response of trees to construction activity is the focus of this article. The observations (Table 1) are based primarily on the experience of the primary author with trees in disturbed sites. This experience began while he was at Southside Nurseries (1958 to 1969) and continues through his 26 years in academics to date.
Observations are confined to native and naturalized trees since they are the ones likely to be found at new construction sites, and they are the plants that the new owner will likely want to retain.

A tree's environment may be altered greatly during construction. A look at the individual changes that may occur will help in understanding what we ask of trees from the time when the first shovel is turned in the subdivision to eight years or so after the completion of the last round of construction. Construction damage to trees may not be apparent to the homeowner for three to eight years after the damage was inflicted. This makes it difficult for the homeowner to relate cause and effect.

## Altered Drainage Patterns

Placing sewers, streets, curbs, and gutters at a site will greatly alter drainage patterns. Water that once had a chance to soak in after a rain now is whisked into the storm sewer, bypassing the ground water system. Ground water resources for growing roots are the poorer. The soil dries out faster since less water is stored, and the effects of droughts are heightened. This effect is worse at the bottom of a hill where plants requiring moist but well drained soils are often found.

## Debris in the Soil

In many cases, virtually anything and everything is buried at a construction site. Concrete spills, sheetrock, and plywood are examples of construction debris that cause disturbed soil profiles and alter soil moisture distribution patterns. In one example there was a site where plants had been failing for several years. A soil probe identified the problem — an entire 4x8

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sheet of plywood buried about one foot below the soil surface.

## Decreased Grades

Reducing the grade around existing trees is as serious as increasing the grade. Remember that the majority of feeder roots are found in the top four inches of soil. Large portions of the feeder roots thus are lost by soil removal. Moreover, this situation results in an altered drainage pattern.

## Disturbed Soil Profiles

Water does not move downward from a fine textured soil such as clay into a coarser textured soil such as a sand or gravel. Water remains in the fine textured soil at the interface of the soil types until the head pressure is sufficient to force the water into the coarser soil.

This is called a perched water table, and the impounded water can kill sensitive plants such as yews. This explains why adding gravel into the bottom of a planting hole will not increase drainage.

## Impounded Water

Sometimes water is impounded, creating a boggy site from one that had been well drained. Many native trees will not tolerate poor drainage. Upland species are most vulnerable. Oxygen levels in the soil are reduced as water fills the pore spaces that formerly held oxygen. Carbon dioxide is retained as diffusion is reduced. The double whammy takes its toll.

## Increased Competition

Often little thought is given to the effects of altering plant communities. For example, it is uncommon to see an attractive sugar maple growing in an attractive bluegrass lawn. Either the healthy sugar maple shades out the grass or the tree slowly declines due to competition from the lush highly competitive grass.

Allelopathy, the release by one plant of substances toxic to nearby plants, can also be a factor. Some allelopathic relationships, such as the effects of walnut on rose, are well known, but many are poorly understood.

## Increased Grades

Builders are often faced with a disposal problem with the soil removed from digging the basement. The lowest cost solution is to spread the spoil from the basement over the existing soil. The spoil is often finer textured than the original soil, resulting in a disturbed soil profile.

Adding soil over the root zone of existing trees is problematic. As little as four inches of fill may kill a mature climax forest tree such as linden, sugar maple, and beech.

## Increased Light

Another alteration of the suburban landscape relative to the woodland it replaces is increased light. Reduced numbers of trees and the resulting increase in reflected light contribute to a much higher light level.

Reflected light alone can double the incident light levels to which a plant is exposed. Thin barked trees such as beech seem particularly sensitive to this problem.

## Increased Temperatures

The heat island effect of our cities is well known. Soil and air temperatures both rise in the city. Plants may be more sensitive to soil temperature changes since air temperatures normally fluctuate more.

Plants that are at the southern part of their natural range are most likely to be sensitive in this situation. Paper birch would be such a plant in Ohio.

## Interrupted Nutrient Cycling

This is not a factor that is likely to have severe consequences itself, but it is one more stress with effects that are additive. Micronutrients are likely to be the ones that are found to be

deficient. In a woodland situation, nutrients are recycled as foliage, branches, and stems decompose over time. Removal of leaves and other organic debris takes the nutrients they contain out of the system.

## Modified Insect and Disease Complexes

A number of insects and diseases attack weakened hosts. The increased stress levels associated with urban sites often predispose the plant to attack.

Engraver beetles and metallic wood boring beetles are insects that are associated with increased stress levels. Nectria canker and cankerstain are diseases that are stress related.

## Reduced Root Zones

Trenching, roads, and sidewalks all reduce the soil volume that is available for tree roots. A number of people are trying to evaluate the relationship between the size of a tree and its planting pit size. One estimate suggests that 225 square feet is needed to maintain a 10-inch tree in good condition. Think of the implications associated with trapping a tree in a 4x4 sidewalk cut. Is it any wonder that trees in urban areas have a reduced life expectancy?

**Table 1. Observations on the performance and adaptability of various native and naturalized trees to construction activities in Ohio.**

| Scientific Name | Tree | Rating | Comments |
|---|---|---|---|
| *Acer negundo* | Box-Elder | Good | Tolerant of some additional fill. Will adapt to urban situations. |
| *Acer rubrum* | Red Maple | Fair | Plant very intolerant of wounding. Requires acid to neutral soils. |
| *Acer saccharinum* | Silver Maple | Good | Adapts to urban situations. More tolerant of wounding than red maple. Will tolerate some additional fill. |
| *Acer saccharum* | Sugar Maple | Low | Intolerant of fill. Intolerant of increased light and restricted root space. |
| Aesculus glabra | Ohio Buckeye | Low | Does not adapt to increasing light or increased stress. Sensitive to wounding. Will tolerate some fill. |
| *Ailanthus altissima* | Tree-of-Heaven | Good | Plant adapts readily to urban situations. |
| *Amelanchier arborea* | Downy Serviceberry | Good | Plant adapts to high light and urban situations including low oxygen. Adapts to restricted root space. |
| *Amelanchier laevis* | Allegheny Juneberry | Good | Adapts to urban situations including low soil oxygen. Adapts to restricted root space. Adapts to increased light. |
| *Betula nigra* | River Birch | Good | An acid-soil-requiring plant. Plant is quite tolerant of urban stress. Some fill will be tolerated. Plant will tolerate urban conditions. |

**Table 1 (Continued). Observations on the performance and adaptability of various native and naturalized trees to construction activities in Ohio.**

| Scientific Name | Tree | Rating | Comments |
|---|---|---|---|
| *Betula papyrifera* | Paper Birch | Good | This plant is sensitive to bronze birch borer which is much more severe following any kind of increased stress load. This plant will not tolerate increased heat and light especially in the root zone. Mulching is advisable. Out of its natural range, it is intolerant of construction activity. |
| *Betula populifolia* | Gray Birch | Good | An acid soil requiring tree. Will tolerate sterile soils. Outside of its natural range, this plant is susceptible to bronze birch borer which is often fatal. Urban or construction stresses will exacerbate this problem. |
| *Carpinus caroliniana* | Hornbeam | Fair | This plant's service life in its natural range is short due to the presence of hornbeam borer. Increased stress will result in more frequent and more severe attacks. This plant can persist as a forest understory plant if minimum disturbance has been experienced. Excellent follow-up care is required for this plant to persist following construction activity. Once the plant is reestablished it is stable. |
| *Carya cordiformis* | Bitternut Hickory | Good | Branching pattern generally better than pecan; however, if the plant has codominant leaders they can be structurally unstable. Plant will tolerate some fill. |
| *Carya glabra* | Pignut Hickory | Good | Plant generally has a structurally stable branching pattern. Plant is tolerant of some fill. Plant is windfirm. |
| *Carya illinoensis* | Pecan | Good | Open grown plants often have codominant leaders and a resulting vase-shaped habit of growth, which is structurally unstable. Will tolerate some fill. |
| *Carya ovata* | Shagbark Hickory | Good | Plant will tolerate some fill. Plant normally has excellent branch structure. Growth rates and wound closure rates are slow. Plant is windfirm. |
| *Carya tomentosa* | Mockernut Hickory | Good | Tolerates some fill. Plant is windfirm. |
| *Catalpa speciosa* | Northern Catalpa | Good | Tree adapts easily to urban conditions. Tree tolerant of wounding. Wood very resistant to decay. Tolerates disturbance. |
| *Celtis occidentalis* | Hackberry | Good | Tolerant of urban conditions and restricted root |

**Table 1 (Continued). Observations on the performance and adaptability of various native and naturalized trees to construction activities in Ohio.**

| Scientific Name | Tree | Rating | Comments |
|---|---|---|---|
| | | | space. Tolerant of alkaline soils. Tolerant of urban sites. Tolerates some fill. |
| *Cercis canadensis* | Redbud | Fair | Plant adapts to calcareous soils. Plant will not adapt to high or reflected light as a single plant. |
| *Cornus florida* | Flowering Dogwood | Low | Forest understory plants do not adapt readily to removing the tree canopy from above them. Intolerant of disturbance. |
| *Crataegus crus-galli* | Cockspur Thorn | Good | Plant adapts to high light and urban situations. Sensitive to windthrow if the plant is limbed up. Tolerates some disturbance. |
| *Crataegus phaenopyrum* | Washington Thorn | Good | Plant readily adapts to high light and urban stress. Plant highly susceptible to windthrow. Tolerates some disturbances. |
| *Crataegus punctata* | Dotted Hawthorn | Good | Plant adapts to high light and urban situations. Plants subject to windthrow. Tolerates disturbance. |
| *Diospyros virginiana* | Persimmon | Good | Adapts readily to an urbanizing situation. Tolerates poor soils. Adapts to low oxygen sites. |
| *Fagus grandifolia* | American Beech | Low | Protect the tree from construction activity under the dripline of the tree. Mulch over the root zone following construction is highly desirable. Tree is sensitive to increased light following removal of surrounding forest. Major branches are sensitive to sunscald following loss of surrounding trees. Thin bark makes this tree sensitive to wounding. A poor wound response makes this tree vulnerable to decay. |
| *Fraxinus americana* | White Ash | Fair | Does not adapt to changes in moisture levels. Either excess or reduced moisture will cause problems. Decline occurs over time. |
| *Fraxinus pennsylvanica* | Green Ash | Good | May require protection from borers during reestablishment period. Adapts to low oxygen environments. Plant has a good wound response. Tolerates some fill and restricted root zone. |
| *Fraxinus quadrangulata* | Blue Ash | Good | Plant has good wound response and adapts to an urbanizing situation. Decline occurs over time. |
| *Ginkgo biloba* | Ginkgo | Good | Tolerant of urban conditions. Reestablishment period can be protracted. Tolerates restricted root space. |

**Table 1 (Continued). Observations on the performance and adaptability of various native and naturalized trees to construction activities in Ohio.**

| Scientific Name | Tree | Rating | Comments |
|---|---|---|---|
| *Gleditsia triacanthos* | Honey-Locust | Good | Plants will adapt to high light in urban situations. Plant sensitive to wounding when young, but somewhat resistant as an older plant. Tolerates disturbance. |
| *Gymnocladus dioica* | Kentucky Coffee-Tree | Good | Plant adapts to high light and urban situations. Tough bark is resistant to mechanical injury. Tolerates disturbance. |
| *Ilex opaca* | American Holly | Good | Plant adapts readily to urban situations. Tolerates restricted root zone. Tolerates some fill. Bark is thin. Acid soil requiring. |
| *Juglans nigra* | Black Walnut | Good | Plant requires good soil conditions in order to perform. Under poor conditions, this plant is severely stunted. Tree has a tendency to defoliate in August under Ohio conditions. Fruit is a serious litter problem. |
| *Juniperus virginiana* | Eastern Red Cedar | Good | Will survive in very low nutrition soils. Tolerates urban conditions. Salt intolerant. Tolerant of wounding. |
| *Liquidambar styraciflua* | Sweetgum | Good | Plant can adapt to a low-oxygen environment and restricted root space. Reestablishment period can be protracted. Plant can adapt to high light situations. Plant can tolerate some fill. |
| *Liriodendron tulipifera* | Tuliptree | Fair | The tree is sensitive to wounding, but tolerant of soil compaction. Plant intolerant of sterile soil conditions. |
| *Maclura pomifera* | Osage-Orange | Good | Very tolerant of urban conditions. Tolerant of disturbance. Tolerant of high light. Tolerant of alkaline soil conditions. Will adapt to low oxygen environments. This tree is a tough survivor. Tolerates mechanical damage. Tolerates some fill. |
| *Magnolia grandiflora* | Southern Magnolia | Good | Tolerant of urban conditions. Will adapt to low oxygen environment. Intolerant of wounding. Plant is often left foliaged to the ground. Tolerates soil compaction. |
| *Magnolia virginiana* | Sweet Bay Magnolia | Good | Will adapt to low-oxygen environments. Urban tolerant. Intolerant of wounding. |
| *Malus coronaria* | Sweet Crab | Good | Will adapt to urban situations and high light. Plant is disease prone to cosmetic diseases. Tolerant of wounding. Tolerates some fill. |

**Table 1 (Continued). Observations on the performance and adaptability of various native and naturalized trees to construction activities in Ohio.**

| Scientific Name | Tree | Rating | Comments |
|---|---|---|---|
| *Malus ioensis* | Prairie Crab | Good | Disease-prone plant which adapts to high light and urban conditions. Tolerant of wounding. |
| *Malus pumila* | Apple | Good | Adaptable to high light in urban situations. May be disease prone. Tolerant of wounding. Tolerates some fill. |
| *Morus alba* | White Mulberry | Good | Urban tolerant. Tolerant of disturbance. Tolerates some fill. |
| *Morus rubra* | Red Mulberry | Good | Urban tolerant. Tolerant of disturbance. Tolerant of high reflected light. Tolerates some fill. |
| *Nyssa sylvatica* | Black-Gum | Good | Adapts to urban situations. Acid-soil requiring plant. Will adapt to low-oxygen site. |
| *Ostrya virginiana* | Hop-Hornbeam | Fair | This plant's life expectancy, particularly in the southern part of its range, is short due to hornbeam borer. The tendency of this pest to attack stressed plants normally results in the loss of this plant following construction activity. This plant will persist as a forest understory plant. |
| *Oxydendron arboreum* | Sourwood | Fair | Acid-soil-requiring plant. Can adapt to low-oxygen sites. |
| *Paulownia tomentosa* | Royal Paulownia | Good | Plant adapts to urban situations readily. Tolerates disturbance. |
| *Picea abies* | Norway Spruce | Good | Loss of this plant in the landscape is often due to windthrow. Raising the lower limbs will increase the probability of this plant being lost. Intolerant of excessive root loss. Tolerant of urban conditions. |
| *Picea pungens* | Blue Spruce | Good | This plant is often lost due to windthrow in the landscape. Anything that will increase wind and increase the sail will likely result in greater wind instability. Tolerant of wounding. Tolerant of urban conditions. |
| *Pinus banksiana* | Jack Pine | Good | A tough survivor. Following construction, often removed because the plant is not terribly attractive. Tolerant of poor soil. Tolerates some fill in sandy soils. |
| *Pinus echinata* | Shortleaf Pine | Good | Acid-soil-requiring pine. Tolerant of urban conditions. Tolerant of wounding. Tolerates some fill. |

**Table 1 (Continued). Observations on the performance and adaptability of various native and naturalized trees to construction activities in Ohio.**

| Scientific Name | Tree | Rating | Comments |
|---|---|---|---|
| *Pinus nigra* | Austrian Pine | Good | Will tolerate some fill. Will tolerate increased light and heat loads under Ohio conditions. Pine tip blight is potentially fatal disease. Tolerates wounding. |
| *Pinus resinosa* | Red Pine | Good | Not tolerant of increased heat loads. Tolerant of wounding. |
| *Pinus rigida* | Pitch Pine | Good | Tolerates sterile soil conditions. Tolerant of wounding. Tolerates increased heat loads. Urban tolerant. |
| *Pinus strobus* | White Pine | Fair | Will do better with a mulched root zone. Intolerant of changes in soil moisture as this plant requires moist well-drained soils. Intolerant of excess moisture. Very intolerant of aerial salt. |
| *Pinus sylvestris* | Scotch Pine | Good | Intolerant of increased moisture levels. Decreased moisture levels can increase insect sensitivity. This plant is one of the more difficult pines to transplant. |
| *Pinus virginiana* | Virginia Pine | Good | Intolerant of calcareous soils. Tolerant of very sterile conditions. Tolerant of wounding. Tolerates some fill. Tolerates urban conditions. |
| *Platanus occidentalis* | Sycamore | Good | Plant is tolerant of urban stress. There is a natural tendency to self prune. Declining trees are dangerous when situated in urban sites. Plant adapts to low-oxygen sites. Large size is a concern in urban area. |
| *Populus deltoides* | Eastern Cottonwood | Good | Tolerates urban conditions. Tolerates some fill. This plant's tremendous size can be a concern in urban areas. |
| *Populus grandidentata* | Bigtooth Aspen | Low | In the southern part of this plant's range, such as Ohio, increased light and soil temperatures can be fatal. Tolerant of poor soils. |
| *Prunus serotina* | Wild Blackcherry | Low | Very young plants seem to adapt to altered environment. Older plants often decline over time following any disturbance. |
| *Quercus alba* | White Oak | Good | Thick bark provides some protection against mechanical damage. In its native range this plant is frequently one of the more common survivors following construction activity. |
| *Quercus bicolor* | Swamp White Oak | Good | Alkaline soil tolerant. Can adapt to low oxygen sites. Will tolerate some fill. |

**Table 1 (Continued). Observations on the performance and adaptability of various native and naturalized trees to construction activities in Ohio.**

| Scientific Name | Tree | Rating | Comments |
|---|---|---|---|
| *Quercus coccinea* | Scarlet Oak | Fair | Less adaptable to a low-oxygen environment than most oaks. Often found in poor soils. |
| *Quercus imbricaria* | Shingle Oak | Good | Plant is adapted to acid or neutral soils. Shorter lived than the white oak group. Plant is urban tolerant. |
| *Quercus macrocarpa* | Bur Oak | Good | Thick bark provides protection from fire and mechanical damage. An alkaline soil tolerant oak. Can adapt to low oxygen sites and tolerates some fill. |
| *Quercus montana* | Chestnut Oak | Good | Often found in shallow, rocky soils where any disturbance of the site can result in the loss of the plant. In good sites the plant is quite tolerant of disturbance. This tree's thick bark provides some protection against mechanical damage. |
| *Quercus muehlenbergii* | Chinquapin Oak | Good | An alkaline-soil tolerant oak. Tolerates disturbance. This plant tends to have an excellent branching pattern. Adapts to an urban site. |
| *Quercus nigra* | Water Oak | Good | Plant adapts to lower-oxygen situations better than many oaks. Adapts readily to urban situations. |
| *Quercus palustris* | Pin Oak | Good | Adaptable to low-oxygen environments. Requires acid to neutral soils. Plant is urban tolerant. |
| *Quercus phellos* | Willow Oak | Good | An urban tolerant species requiring acid soils. Tolerates some fill. |
| *Quercus rubra* | Red Oak | Fair | Shorter lived and less tolerant of disturbance than the white oak group. Urban tolerant. |
| *Quercus shumardii* | Shumard Oak | Good | Tolerant. Will adapt to poor oxygen sites. Urban tolerant. |
| *Quercus stellata* | Post Oak | Good | Tolerant of poor soils. Tolerant of urban conditions. Thick bark provides some protection from mechanical injury. |
| *Quercus velutina* | Black Oak | Fair | Less tolerant of compaction than many other oaks. Shorter lived than oaks in the white oak group. |
| *Rhus typhina* | Staghorn Sumac | Good | Plant readily regenerates from root suckers forming large colonies after a disturbance. Older plants often lost. |

Table 1 (Continued). Observations on the performance and adaptability of various native and naturalized trees to construction activities in Ohio.

| Scientific Name | Tree | Rating | Comments |
|---|---|---|---|
| *Robinia pseudo-acacia* | Black Locust | Good | A high population of this tree results in sensitivity to borer damage or death. Urban tolerant. Tolerates some fill. |
| *Salix babylonica* | Weeping Willow | Fair | Disturbance can predispose this plant to cankering which can cause significant injury and/or death. The average plant is relatively short-lived but many old specimens are known. Will tolerate some fill. Spreads asexually. |
| *Salix nigra* | Black Willow | Good | Wetland species. Tolerant of low oxygen levels. Poor wound response can result in hollows in the main stem and thus structural instability. Will tolerate some fill. |
| *Sassafrass albidum* | Sassafras | Good | Plant regenerates from root suckers. Root sucker generated plants can be killed with minimal root disturbance due to the root distribution pattern. Plant tolerant of sterile soils. |
| *Thuja occidentalis* | Arborvitae | Good | Tolerates urban conditions. Tolerates excess moisture if given time to adapt. Tolerates wounding. Often found on rock outcrops where root disturbance can be fatal. Tolerates some fill. |
| *Tilia americana* | Basswood | Low | Declines slowly over time. Considered by foresters as an indicator plant for environmental change. Mulching root zone will help to retain this plant. Intolerant of fill. |
| *Tsuga canadensis* | Canadian Hemlock | Low | Intolerant of fill. Must be protected from soil compaction. Sensitive to increased soil temperatures and decreased soil moisture levels. Intolerant of excess moisture. |
| *Ulmus americana* | American Elm | Good | Adaptable species to disturbance. Very tolerant of urban conditions. Sensitive to Dutch elm disease and phloem necrosis, both of which are fatal. Will tolerate some fill. Tolerates restricted root space. Tolerates low-oxygen sites. Tolerates mechanical damage. |
| *Viburnum lentago* | Nannyberry | Good | More adaptable in low oxygen situations than *Viburnum prunifolium.* This plant adapts readily to urban damage. |
| *Viburnum prunifolium* | Black-Haw | Good | A forest understory plant which will adapt readily to higher light situations. Adapts readily to urban situations. |

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